

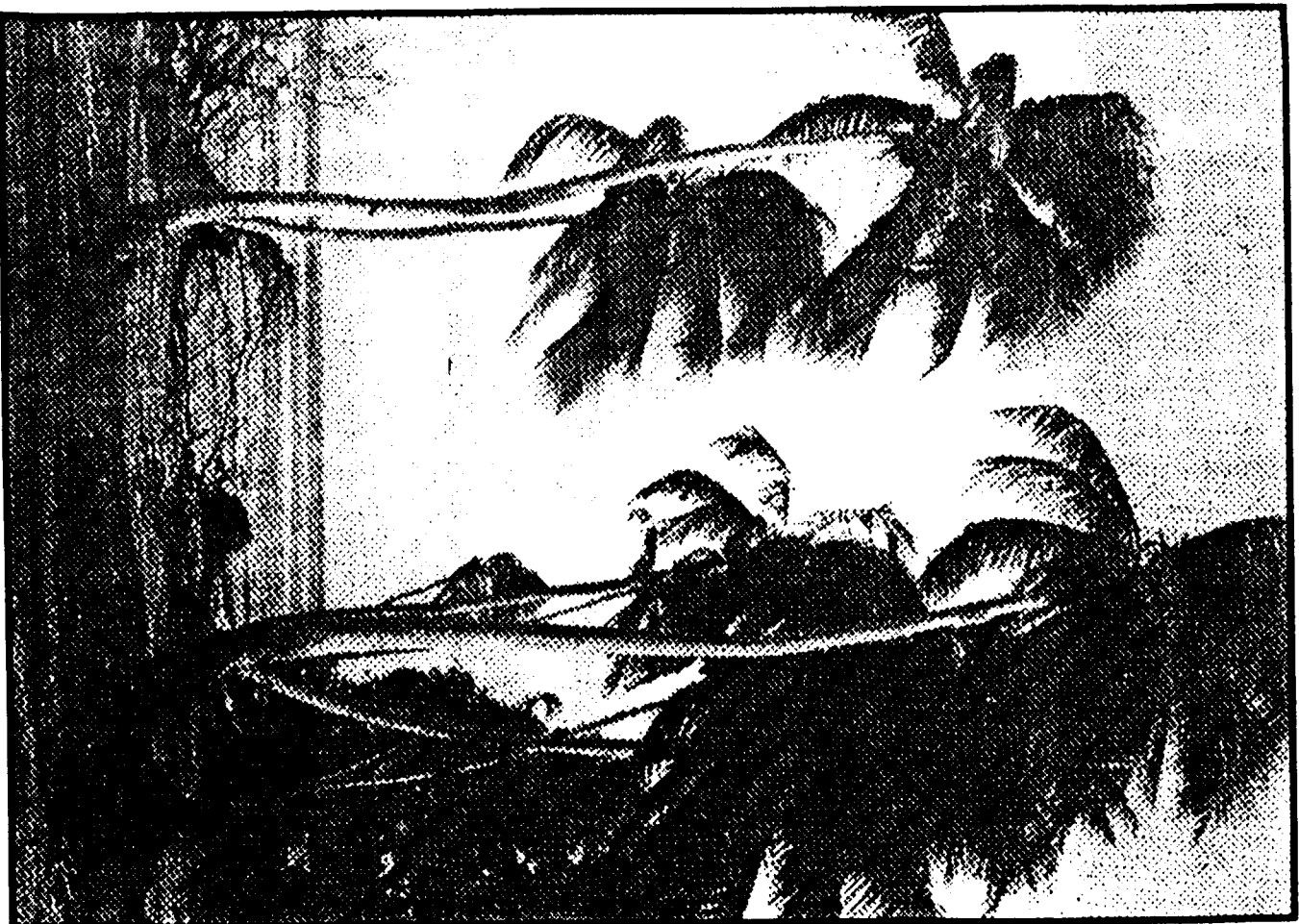
MAKING RONGELAP HABITABLE:

**PROPOSED WORKPLAN
FOR A PHASE 2
COMPREHENSIVE STUDY**



Prepared in Accordance with the
COMPACT OF FREE ASSOCIATION
ACT OF 1985
Public Law 99-239

Tom Bellis E/PC E-4
DOE



P&D Technologies



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An Ashland Technology
Company

*Planning
Engineering
Transportation
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April 12, 1989

Senator Jeton Anjain
Mayor Willie Mwetko
Rongelap Atoll Local Government Council
Republic of the Marshall Islands
P.O. Box 1006
Majuro, Marshall Island 96960

Gentlemen:

The attached Phase 2 Independent Comprehensive Work Plan is attached for your review and action. The Work Plan has been accomplished in accordance with the terms of the contract between the Rongelap Atoll Local Government Council and P&D Technologies.

The Phase 2 Work Plan proposed herein identifies and proposes a process and study for resolving outstanding health, radiological, environmental and socioeconomic issues relating to the habitability of Rongelap Atoll.

The Work Plan includes the following features:

First, it establishes a process for resolving the longstanding issues regarding the habitability of Rongelap Atoll and for implementing the requirements of the Compact of Free Association. The creation of a **Rongelap Radiological and Health Study Management Committee** is recommended. It would be given the authority to oversee the operation and success of the Phase 2 study. A distinguished group of individuals having a broad spectrum of viewpoints and depth of experience would be appointed to serve in this capacity. It is important that these individuals have the necessary credibility and objectivity to assure the interest of all parties – Rongelap, the Republic of the Marshall Islands, the U.S. Department of Energy and the U.S. Government – are dealt with fairly and properly.

Second, the plan proposes the full use of existing DOE radiological and health data collected over the years on the Rongelap people and Rongelap Atoll (to the extent such data is made available), and provides for its review by independent consultants, staff and the Management Committee. We believe this will eliminate much of the uncertainty that has developed since the DOE Bilingual Report was issued in 1982. The DOE data base will be buttressed, as necessary, with new data and information, and will be reanalyzed in the context of the new data. Appropriately stringent standards and criteria, as determined by the Management Committee, will be employed to determine risk.

Third, outstanding issues relating to disputes over various scientific approaches being employed in determining dose will be decided by the Management Committee after thorough review and analysis. We believe this will eliminate uncertainty over which approaches are adequate to assure the health and safety of the Rongelap people upon resettlement, or whether new approaches are desirable.

Fourth, the study will develop complete medical profiles and records on each member of the Rongelap population, so that every Rongelap individual will be able to judge their risk when resettlement comes. This survey will be useful in determining the general health of the Rongelap population and the kinds of health problems they can expect in the coming years, whether resettlement occurs or not.

Senator Jeton Anjain
Mayor Willie Mwetko

April 12, 1989
Page 2

Fifth, the Work Plan includes an independent plutonium and transuranic dose assessment with particular emphasis on the impacts of these radiological elements on infants and children.

Sixth, the study will examine fully the economic, environmental, and social impacts of radiation on Rongelap Atoll and the Rongelap people and will recommend solutions to achieve habitable standards upon resettlement.

Seventh, various options for cleanup of Rongelap Atoll will be examined. We also propose that the plutonium mining technology employed by the U.S. Defense Nuclear Agency in the cleanup of Johnston Island be tested on Rongelap Atoll to determine if it will be useful in reducing environmental impacts and costs of cleanup.

Finally, we believe this study will form a new basis for improved understanding and communication between Department of Energy officials administering Marshall Island's programs and the Rongelap people. In the context of a truly independent, comprehensive study, the DOE data and information can be utilized and verified to the satisfaction of the Rongelap people and will become the basis for credible decisions regarding resettlement and decontamination of Rongelap Atoll.

We thank you for the opportunity to work with the Rongelap Atoll Local Government Council in the preparation of this Work Plan report. We sincerely hope that what we have proposed will assist the Rongelap Atoll Local Government Council, officials of the Republic of the Marshall Islands and the United States Congress in decision-making with regard to the future of the Rongelap people and Rongelap Atoll.

Sincerely,

P&D TECHNOLOGIES



Robert K. Lane
Director of Technical Studies

RKL/cr

**RECOMMENDED PHASE 2 WORK PLAN
FOR A
COMPREHENSIVE AND
INDEPENDENT RADIATION STUDY OF RONGELAP ATOLL

AS PROVIDED IN THE

COMPACT OF FREE ASSOCIATION**

APRIL 12, 1989

TABLE OF CONTENTS

	PAGE
Transmittal Letter	
I. INTRODUCTION: A RONGELAP INITIATIVE	1
HABITABILITY YARDSTICK	1
RONGELAP'S DIRECTIVE TO P&D TECHNOLOGIES	2
HISTORICAL BACKGROUND	3
RONGELAP CONCERNS	4
II. ELEMENTS OF THE WORK PLAN	9
III. PHASE 2 STUDY ORGANIZATION	14
Rongelap Radiological and Health Study Management Committee (RRHSMC)	14
Staffing Considerations	15
Office Location	16
Consultants	16
Study Timeframe	17
IV. UNRESOLVED HEALTH, RADIATION, AND HABITABILITY ISSUES	20
BASELINE HEALTH SURVEY	20
DOSE ASSESSMENT OF THE RONGELAP POPULATION	23
Radiation Dose from Cesium and Strontium	25
Diet and Dose Assessment	26
Plutonium Dose	28
Average vs. Individual Dose	31
Past and Future Dose	32
Child and Infant Dose Assessment	33
Radiation and Cleanup Standards	35
ECONOMIC IMPACTS	37
SOCIOLOGICAL AND PSYCHOLOGICAL IMPACTS	40
V. STUDY IMPLICATIONS	41
VI. SUMMARY OF RECOMMENDATIONS	42
VII. BUDGET ESTIMATES	46
REFERENCES	47
APPENDIX	
Appendix A:	Compact of Free Association Public Law 99-239, Jan 14, 1986
Appendix B:	Resume, Robert K. Lane
Appendix C:	Location Map, Republic of the Marshall Islands
Appendix D:	Map excerpt from "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands that were surveyed in 1978," DOE, 1982.

TABLE OF CONTENTS
(CONT)

- Appendix E: Rongelap Assumed Daily Diets (DOE), excerpted from Rongelap Reassessment Report.
- Appendix F: Brookhaven Data From Internal and External Exposure, excerpted from Rongelap Reassessment Report.
- Appendix G: "Plutonium Mining for Cleanup, by E.T. Bramlitt, Health Physics.

"Habitability - Condition of premises which permits inhabitants to live free of serious defects to health and safety" - Black's Law Dictionary

I. INTRODUCTION: A RONGELAP INITIATIVE

By contract, November 21, 1988, the Rongelap Atoll Local Government directed P&D Technologies, Inc., Phoenix, Arizona, to prepare a recommended Phase 2 Work Plan for the comprehensive and independent radiation study of Rongelap Atoll as set forth in Section 103(i) of Public Law 99-239 and "the Compact of Free Association between the Republic of the Marshall Islands and the United States Government."

P&D Technologies is a wholly-owned subsidiary of Ashland Technology Corporation, and provides engineering, planning, asset management and environmental consulting services. Robert Lane was chosen for this assignment because of his extensive experience in formulating and conducting major investigations and studies on complex governmental natural resource programs (see resume of Robert K. Lane in Appendix B), and for his experience in Congress and the Department of the Interior.

Rongelap Atoll Local Government Council recognized a comprehensive work plan was required, but did not exist. The Rongelap Council required such a plan as did the Government of the Marshall Islands, the U.S. Congress, and the Executive Branch of the U.S. Government. The Rongelap Council recognized that a document is needed that identifies their needs and attitudes regarding the emphasis required of a Phase 2 study and that such a document will become the basis for a decision on the future of Rongelap Atoll and the Rongelap people. The Rongelap Council believes that the assumptions, data and analyses prepared by nuclear scientists may not include the many human factors that are essential to decision-making about Rongelap. This Work Plan recognizes the importance of previous research and assessment efforts. But it begins from a conclusion based on a review that the DOE data and analysis is an inadequate and incomplete basis for assuring a safe resettlement of the Rongelap people to Rongelap Island or Rongelap Atoll and that, as a result, the Phase 2 comprehensive study authorized by section 103(i) of the Compact for Free Association (Public Law 99-239) should be funded and commenced as soon as possible.

HABITABILITY YARDSTICK

The key overriding objective established by section 103(i) of the Compact is the determination of the **habitability** of Rongelap. Any comprehensive study done pursuant to the Compact should include sufficient data and analysis adequate to determine habitability. "Habitability" is defined in Black's Law Dictionary as "condition of premises which permit inhabitants to live free of serious defects to health and safety." This is the definition used in preparing this Work Plan. Therefore, "habitability" beyond compliance with radiation standards, it also is the condition by which life will be lived on a daily basis once resettlement (and if necessary, cleanup of the Atoll) is accomplished. We believe "habitability" means also the ability to move freely throughout the Atoll without artificial limitations and restrictions that if violated, increase risk to health.

RONGELAP'S DIRECTIVE TO P&D TECHNOLOGIES

As part of the process leading to the development of a Phase 2 Work Plan, P&D Technologies was directed to review, at a minimum, five primary documents that bear directly on the Rongelap radiological and health issues. These documents are:

- o "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978," Department of Energy, Report to the Marshall Islands (1982 DOE Report), November 1982.
- o The Rongelap Reassessment Project, Final Report, July 22, 1988, prepared by Dr. Henry I. Kohn pursuant to the Compact of Free Association.
- o The Compact of Free Association, Public Law 99-239, Section 103(i).
- o House Concurrent Resolution 395, October 21, 1988, introduced by The Honorable Morris K. Udall, Chairman, Committee on Interior and Insular Affairs, House of Representatives; The Honorable Ron de Lugo, Chairman, Subcommittee on Insular and International Affairs, and The Honorable George Miller.
- o Nitijela of the Marshall Islands, Resolution No. 28, November 10, 1988 supporting House Concurrent Resolution 395.

P&D was also directed to consult with a number of individuals and organizations that have been directly involved in various aspects of data collection, analysis, review or governmental policy as it pertains to Rongelap Atoll and the Rongelap people.

In addition, Robert Lane was required to travel to the Marshall Islands and meet with the members of the Rongelap Atoll Local Government, the Chief Secretary of the Republic of the Marshall Islands, and the Rongelap people residing in Ebeye and the Island of Majato, to obtain their views on what should be included in the comprehensive Phase 2 Study Work Plan.

Specifically, P&D Technologies was directed in the November 21, 1988 contract to perform the following tasks:

- (1) **A detailed analysis of the scope of work required for the Phase 2 Study, including timeliness for the implementation and completion of said work and any phases thereof as well as any processes and standards that should be imposed in order to insure the integrity and credibility of the Phase 2 Study;**

- (2) **Recommendations on the specific categories of review to be undertaken and completed as a part of the Phase 2 Study, including recommendations with respect to the need to study and assess**

 - (a) **the radiological conditions of the land and marine environments of the atolls of Rongelap, Ailinginae and Rongerik,**
 - (b) **food chain and diets,**
 - (c) **current health conditions of the Rongelap People,**
 - (d) **chromosome damage,**
 - (e) **radionuclide body burdens,**
 - (f) **matters and issues especially affecting infants and small children, as well as**
 - (g) **any other effects that may be identified.**
- (3) **Recommendations with respect to the individuals and scientists ("study team") required in order to properly implement and complete the Phase 2 Study, including professional disciplines necessitated, structure and operation of the study team, administration by an independent core team if necessary, and identification of specific individuals to undertake the Phase 2 Study.**
- (4) **A detailed budget for the Phase 2 Study.**

P&D was also directed to consult with a number of individuals and organizations that have been directly involved in various aspects of data collection, analysis, review or governmental policy as it pertains to Rongelap Atoll and the Rongelap people, and to meet with the Rongelap people and various leaders of the Marshall Islands and Rongelap government leaders.

HISTORICAL BACKGROUND

More than 40 years has elapsed since the United States began testing nuclear weapons in the Marshall Islands. More than 35 years have passed since the detonation of the Bravo test that forever changed the history of the Northern Marshall Islands and the Rongelap people. More than three decades have passed since the Rongelap people returned to their Atoll in 1957 having been assured by the Atomic Energy Commission and the U.S. doctors that all was safe. Six years ago, the Department of Energy published its 1982 Report on the radiological impacts of weapons testing on the Marshall Islands.

Four years ago, with growing concern that Rongelap was no longer safe for habitation, the Rongelap people abandoned Rongelap Atoll. Today, the majority of the Rongelap people live in Ebeye on Kwajalein Atoll and on the island of Majato 70 nautical miles away. A smaller group resides at Majuro, the capital of the Marshall Islands.

Since 1978 and the ensuing decade, there have been a series of powerful and significant events in the history of the Rongelap people.

The Department of Energy Radiation Study. In 1978, the Department of Energy undertook a study (hereinafter referred to as the 1982 DOE Radiation Study) of radiation in the Northern Marshall Islands. The DOE report was completed in the Fall of 1982, published in November, and presented to the Government of the Republic of the Marshall Islands, representatives of the various atolls, and the Rongelap leaders in December, 1982. DOE went to Rongelap in April, 1983 to present the Report to the Rongelap people.

Nitijela Resolution No. 25, August, 1983. Based on the disclosures contained 1982 DOE Radiation Report, Nitijela of the Marshall Islands unanimously enacted Resolution No. 25 which asks the U.S. Government to evacuate the Rongelap people from Rongelap Atoll based upon disclosures in the 1982 DOE Report indicating that Rongelap Atoll is as contaminated as Bikini and Enewetak Atolls.

Rongelap People Evacuate Rongelap. In May, 1985, the Rongelap people enter self-imposed exile believing that their historical homeland of Rongelap Atoll is contaminated-based on the contents of the 1982 DOE Radiation Report. Generating national and international attention, the Rongelap people requested that Greenpeace evacuate this entire population from the Atoll, including their houses and all belongings to Mejato on Kwajalein Atoll.

Compact of Free Association Mandates Special Review of Rongelap. In January 1986, Section 103(i) of P.L 99-239 mandates special review of the data and conclusions contained in the 1982 DOE Radiation Report.

Republic of the Marshall Islands Contracts for Special Study. In conformance with the Compact of Free Association, in August of 1987, the Republic of the Marshall Islands contracted with Dr. Henry I. Kohn, Berkeley, California to assess the adequacy of DOE data and conclusions contained in the 1982 DOE Radiation Study.

Dr. Henry Kohn Publishes Final Report, Rongelap Reassessment Project, July 1988. Dr. Henry Kohn, pursuant to his contract with the Republic of the Marshall Islands, presented a "Preliminary Report" to the U.S. Congress, April 20, 1988, and the final report (hereinafter referred to as the Rongelap Reassessment Report) was issued in July, 1988. A corrected edition was published March 1, 1989.

Legislation Introduced in U.S. House of Representatives calling for Phase 2 Comprehensive and Independent Study. In October, 1988, representatives Morris K. Udall, Ron deLugo and George Miller introduced House Concurrent Resolution 395 to authorize Phase 2 comprehensive radiation and health study.

Nitijela of the Republic of the Marshall Islands Unanimously Endorses House Concurrent Res. 395 and calls for Phase 2 comprehensive and independent study. Resolution No. 28 also called upon the U.S. to proceed "with a staged clean-up of Rongelap Atoll that will result in the eventual rehabilitation and resettlement of that Atoll."

RONGELAP CONCERNS

Dr. Henry Kohn, author of the Rongelap Reassessment Report concludes in the Rongelap Reassessment Report,

The Rongelap People should ask themselves what further evidence do they want, or what steps taken, to make them feel comfortable...

This Work Plan is in response to this recommendation.

The three general and overriding questions continuing to be asked by the Rongelap people are:

Is Rongelap Atoll Safe?

What is the health of the Rongelap People and would they be safe if they returned to Rongelap Atoll? and

If Rongelap Atoll is not safe from habitation, can it be made safe?

The Department of Energy (DOE) has told the Rongelap leadership and the leaders of RMI that the Rongelap people should ask themselves whether they are willing to accept the risk and inconvenience associated with resettlement. DOE says it is relatively safe to return, and it suggests two options for the Rongelap people: either 1) return to Rongelap Island, limit movement to other islands in the Atoll and live with certain recommended restrictions to minimize radiation dose or 2) remain on Majato or Ebeye or move to some other similar Marshall Island location. The Rongelap people want to return to Rongelap Atoll. They believe the Compact allows for other reasonable options than those presented by DOE, including reasonable cleanup of their Atoll.

The Rongelap people feel the burden of responsibility is not on them to prove that their Atoll isn't safe, but rather is on the U.S. Government to prove that it is. Much hope was placed on the Rongelap Reassessment Report that it would resolve the issues and provide a basis for decisionmaking. It did not. In fact, significant new radiation issues relating to children, plutonium, unreported health data and disagreements between DOE/Lawrence Livermore Laboratory and DOE/Brookhaven Laboratory surfaced that are in need of greater examination. For this reason, the Rongelap Council will no longer rely on other U.S. Government agencies to suggest what needs to be done to assure its people that Rongelap is habitable.

Following a review of the Rongelap Reassessment Report, the Rongelap Council developed a **Statement of Unresolved Issues** and submitted it to P&D. Many of the issues identified in this document have been of great concern to the Rongelap people for many years and some, like the plutonium issue, have emerged from the Rongelap Reassessment Report. Therefore, as a starting point for the Work Plan, the Rongelap people have declared that the following radiation, health and related issues are unresolved at this time:

December 12, 1988

Robert K. Lane
Director of Technical Services
P&D Technologies
1702 E. Highland, Ste. 410
Phoenix, AZ 85016

Dear Mr. Lane:

On behalf of the Rongelap Council, this letter constitutes the **STATEMENT OF UNRESOLVED ISSUES** regarding the radiation problems at Rongelap Atoll. The Final Report of the Rongelap Reassessment Project (July,

1988) has been received and reviewed, and, based upon the findings and conclusions of that Report, the Rongelap Council has determined that:

- o the data contained in the 1982 Department of Energy Report entitled, "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978" is inadequate to fully support the Report's conclusions as to the habitability of Rongelap Atoll;
- o the conclusions as to Rongelap's habitability contained in the DOE 1982 Radiation Report are not fully supported by the data; and
- o therefore the comprehensive independent study of Rongelap, as set forth in Title 1, Section 103(l)(2) of the Compact of Free Association should be immediately undertaken to fully determine the safety and habitability of Rongelap Atoll.

The Rongelap people have concluded that the following general radiation and related issues remain unresolved:

- (1) HEALTH OF THE RONGELAP PEOPLE UNCERTAIN. The Rongelap people do not know the state of their health--individually or as a community. The health problems experienced at Rongelap must be, among other things, compared with the general Marshall Islands population and further, a determination must be made if these illnesses are radiation related. We do not know if the radiation will poison the children of our future generations. Without this critically important information, a decision about resettlement cannot even be considered.
- (2) RADIATION LEVELS THROUGHOUT THE 61 ISLANDS OF RONGELAP ATOLL REMAIN UNKNOWN. The Rongelap people do not know either the levels of radiation throughout the Atoll, the types of radiation contamination, or whether or not the members of the Rongelap community can live on Rongelap Atoll without exceeding U.S. radiation guidelines.
- (3) RONGELAP REASSESSMENT PROJECT REVEALS FOR FIRST TIME THAT PLUTONIUM IS IN RONGELAP PEOPLE. The review directed by Dr. Kohn revealed that there is plutonium in our environment and in our bodies. The DOE has been researching the problem since at least 1973, but has not informed the Rongelap people or the individuals in question. In addition, there is substantial disagreement between DOE laboratories which has not been reported until now. As compared with the lands in the Northern Hemisphere, Rongelap Island has more than 400 times the amount of plutonium in the soil and for other islands in the Atoll, it is more than 4000 times. We do not understand how Rongelap can be safe or why DOE does not

recommend a cleanup program.

- (4) THE FOOD AT RONGELAP AND CONFLICTING U.S. POLICIES. In the past 15 years the Rongelap people have been told to eat more imported food and not to eat local food. We have been told to rely upon imported foods and at the same time, watched the USDA food program be reduced in half. We are told that Rongelap is habitable IF the food program is in place, but the food program is due to expire in less than two years. Despite this fact, all DOE dose assessments are based upon an imported food diet. The DOE diet estimates for their studies keep changing. This is a major area of uncertainty.
- (5) RADIATION AND THE RONGELAP CHILDREN--UNCERTAINTY. In his Report, Dr. Kohn was unable to offer conclusions about the habitability of Rongelap for children. We entered self-imposed exile because of our fears for the Rongelap children. It's almost four years later and uncertainty still haunts Rongelap.
- (6) THE DOE MAP AND RADIATION CONTAMINATION AT RONGELAP. The most important section of the DOE 1982 Radiation Report is numerically coded, two page map which shows that radiation at Rongelap Atoll is as high as that at Bikini and Enewetak Atolls. Yet, the Rongelap people are told by DOE to stay on Rongelap and that it is safe, yet the Bikini and Enewetak people were removed. This is at the heart of Rongelap's concern. The DOE has been asked about this repeatedly since 1982 and the obvious contradiction remains unexplained.
- (7) DOE USE OF AVERAGES IN ALL REPORTS AND STUDIES. The DOE 1982 Radiation Report relies on averages. We recognize that averages may be useful indicators, but are not sufficient to determine habitability for a community. Averages have the ability to conceal as much as it does reveal. The Rongelap community requires, to make an informed judgement regarding future resettlement, complete health profiles for each individual as well as a full understanding as of radiation levels of radiation throughout the atoll. Radiation, when being discussed at Rongelap Atoll, should be discussed in terms of a high and low range, not averages. Dr. Kohn called the DOE 1982 Radiation Report data "meager" in his Report. To impose "averages" on the strength of an insufficient data base is inappropriate.
- (8) THE U.S. RADIATION DOSE GUIDELINES AND THE RONGELAP PEOPLE EXPOSED TO THE BRAVO TEST. Both DOE and the Rongelap Reassessment Project make projections about the amount of radiation the Rongelap people can expect in the next 30 years if they live on Rongelap. It is stated to be within the

U.S. radiation dose guidelines of 5 rem/30 years. However, more than 50 Rongelapese presently living, about 15% of the entire community, have already been exposed to far more than the U.S. guideline. Returning to Rongelap, they will only endure more radiation on top of a near-lethal dose. We do not understand how Rongelap can be declared safe when a substantial portion of the population is over the U.S radiation guideline.

- (9) THE FUTURE ECONOMY OF RONGELAP. Should Rongelap be resettled, we need to be certain that our community can economically survive. We do not want to be a welfare state and fear such implications. The problems at Rongelap have always been stated and limited to radiation. We believe that Rongelap must be considered in more broad terms.

There are many other specific unresolved issues. To assist your effort, we have tried to provide you with a general statement of the major unresolved radiation and radiation-related issues.

It is the desire of the Rongelap people to return to their historical homeland. However, resettlement will only be considered if Rongelap is safe. You have been entrusted with a program of great importance to all the Rongelap people.

You will have our full cooperation.

On behalf of all the Rongelap people, and especially the children, we thank you for undertaking this important assignment.

Sincerely yours,

Senator Jeton Anjain

cc: Mayor Willie Mwekto
Rongelap Council

II. ELEMENTS OF THE WORK PLAN

The elements of the Phase 2 Comprehensive Independent Work Plan fall into seven major program areas:

1. **Organization and Administration.** This is a key element of the Work Plan because it will assure the independence and credibility of the study, the coordination between the various research teams, the proper use of standards and accurate and fair interpretation of data and the smooth coordination and communication between the Government of the Republic of the Marshall Islands and the Department of State and various involved and affected U.S. government agencies.

The administration of the study will be overseen by a distinguished Management Committee (Rongelap Radiological and Health Study Management Committee) appointed by the President of the Republic of the Marshall Islands. The day-to-day affairs of the study will be handled by a staff director and 3 additional staff housed at an office location on the west coast (and possibly of a one-person office in Washington, D.C.) within easy reach of Hawaii and the Marshall Islands.

Independent consultants with particular and specific expertise in various areas will be employed to conduct various aspects of the study.

The timeframe for completion of the study is up to eighteen months; however, the study should be completed as quickly as possible without sacrificing accuracy or completeness. The staff administrators of the proposed Phase 2 study will be asked to bear this in mind and strive to eliminate any delays in completion.

Budget Estimate: \$1,100,000

2. **Task 1(a): Preparation of Personal Medical Record Files.** Obtain medical data and prepare medical records for each Rongelap individual treated over the years by Brookhaven National Laboratory. These past records of blood parameters, surgeries, physical examinations, thyroid functions, etc. are important for interpreting current problems and/or predicting future problems. DOE and Brookhaven National Laboratory cooperation is essential to the completion of this task. Files would be combined with new files developed in Task 1(b) below.

Task 1(b): Baseline Health Survey. The first major task will be a determination of the health conditions of the Rongelap population. This study will not be concerned with the distinction regarding whether certain diseases found in the population are a direct result of radiation. The statistical information that will result from the survey may allow conclusions to be drawn as to whether the Rongelap population has a higher rate of certain types of illnesses than found in other comparative populations. However, this will not be the primary focus of this study. A key guiding principal will be that the health problems need to be fully understood and documented for the entire Rongelap population to either give assurance to the Rongelap people that their bodies are not unduly affected by the residual affects of radiation, or, to the contrary, to inform them of the condition of their health to all informed family (and community) decisions regarding resettlement.

The logistics of this survey require a team of doctors and associated personnel to spend approximately one month on location in Ebeye and Majato, and it will require the full cooperation of the Rongelap Local Government Council to assure that every man, woman and child is informed and made available for a complete

physical examination. It will also require that the consulting team of doctors provide all of the necessary medical facilities and equipment on site, including electric generators, which will be needed on Majato. Transportation of the team to and from the Marshall Islands could be provided by the U.S. Government, which has regular flights between Hawaii and Kwajalein Atoll, and a U.S. Navy or Coast Guard vessel could be utilized for the trip to Majato. This would expedite the study and substantially reduce costs. If this cannot be arranged, charter airline services and appropriate ship rental will be required (the budget includes costs for commercial logistic support, if necessary). It is anticipated that this consultant group will be selected on the basis of a request for proposal issued by the staff and the Management Committee.

Work Products: Health risk assessment report for Rongelap Population

Complete personal medical files on each Rongelap Individual

Budget estimate: \$920,000 plus \$100,000 for logistic support

3. **Task III: Radiological Survey.** The purpose of this survey will be to collect additional soil, water, food and marine samples on all the islands within Rongelap Atoll as necessary to complement and enhance the existing data base developed by the Department of Energy and its contractors and to provide a clear picture of the present levels of contamination of the area. This survey will include:
 - a. Complete review and analysis of raw data made available from DOE and its contractors and a determination of the need for additional sampling and sampling locations.
 - b. One or more field trips to Rongelap Atoll to gather additional samples. The U.S. government's cooperation in providing logistical ship support to and from Rongelap Atoll as necessary to accommodate the consulting team of specialists will be necessary.
 - c. Specific attention to the need for additional data on the extent of plutonium and other transuranic contamination of the Atoll.
 - d. Incorporation of survey result into dose assessment

Work Products: Radiological assessment report

Detailed map of contaminated areas

Recommendations for decontamination and cleanup

Budget Estimate: \$1,400,000 plus \$200,000 for logistic support

4. **Task IV: Bioassay Sampling, Monitoring and Diet Survey.** The purpose of this task is to determine the committed whole body dose of the radiation each member the Rongelap Community. This will include full review of DOE data for each member of the exposed and control groups that have been tested and monitored over time by the DOE. This will entail extended field trips to Ebeye and Majato and the cooperation of the Rongelap Local Government Council to assure cooperation and availability of the Rongelap people. The program will include accomplishing the following subtasks:

- a. Review of Brookhaven cesium whole body count data, determination of data adequacy for assessment purposes and identification of members of Rongelap community who need additional monitoring. Coordinate with DOE to assure completion of monitoring requirements.
- b. Obtain urine samples for strontium and plutonium analysis from all members of Rongelap population, develop sampling procedures that assure prevention of sample contamination.
- c. Coordinate with DOE Brookhaven Laboratory in the fission track analysis of urine samples to determine dose for Plutonium 238 and 239, and participate as observers to assure independence of study.
- d. Obtain in-situ liver samples from exposed and residual groups for analysis for americium and other transuranics.
- e. Development of realistic mixed food and local food diets; a competent and nationally recognized dieticians will be required to develop distribute and analyze results from diet questionnaires and to coordinate with RMI officials, staff and other consultants in the development of diets that can reasonably be met on Rongelap Atoll after resettlement occurs. The diet consultant will be required to spend several weeks in the field and it is anticipated that diet information will be gathered as bioassay sampling occurs to eliminate delay and to minimize cost and confusion.

Work Products: Complete, accurate data base for dose assessment

Acceptable diet models for use in strontium and plutonium analysis

Report on radiological status of Rongelap people prior to resettlement

Budget Estimate: \$700,000

5. **Task V: Dose Assessment.** This element of the Phase 2 study will focus on analysis of the radiological data for the purposes of determining the whole body dose for the Rongelap population (1) if resettlement occurs or (2) in the event certain restorative actions are taken to eliminate exposure to remaining radioisotopes on Rongelap. Data will be displayed in such a way as to develop doses demonstrating the upper range of risks to the population, as compared with appropriately stringent standards. This element will contain the following subtasks:

- a. Review and recommend to staff and Management Committee appropriate standards.
- b. Perform pathway analyses on various radioisotopes, taking into account, exposure via air, soil, food, and water.
- c. Recommend methods to the management committee for selection and use of excretion formula for measuring plutonium dosage and obtain their approval of methodology.
- d. Determine final 30 and 50 year dose estimates and reconcile and

explain in final report the differences between resulting dose estimates and those developed by DOE.

- e. Clarify significance of the Bravo exposure dose received by the exposed population and its bearing on risk to those individuals of further radiation exposure.
- f. Evaluate compliance with standards.

Work Products: Dose assessment for Rongelap population

Individual dose assessments

Evaluation of compliance with standards

Budget Estimate: \$450,000 (includes \$50,000 for cleanup consultant)

6. **Task VI: Economic and Environmental.** The purpose of this element of the study will be to develop an understanding of the economic activity that can be expected under various resettlement and restoration alternatives. Consultants will be required to examine the relationship between decontamination of the Rongelap Atoll and the need to develop a basis for general economic activity for the population. Traditional and new potentially viable economic activities should be studied. One particular critical aspect of this study will be assessment of the market problems associated with attempting to sell copra and other locally grown and produced food and fiber to markets aware of the recent contamination history. Another key issue for review is the need for routine access to all the islands in the Atoll for food gathering as well as nearby Rongerik and Ailinginae, and the importance of vegetation preservation/restoration during cleanup. Finally, vegetation for agriculture, aesthetic purposes (tourism) and technological concepts for strengthening economic prospects will be examined.

Work Products: Economic feasibility study

Evaluation of economic/employment alternatives

Development of economic guidelines for resettlement

Budget Estimate: \$230,000

7. **Task VII: Sociological/Cultural Support.** The purpose of this study is to identify cultural and lifestyle factors that have a bearing on the ability of the Rongelap people to live within certain restrictions that may be imposed should resettlement occur. Psychological problems and constraints resulting from radiation history will also be assessed. In addition, sociological factors identified in this study will be employed in the pathway analysis and dose assessment study. Subtasks include:

- a. Review data developed by Peace Corps volunteers on the diets of infants and small children and refine, modify expand or continue that program.
- b. Identify sociological problems that may result from resettlement and recommendations for reducing or eliminating problems.
- c. Provide information and support to sampling, monitoring and diet survey team.

Work Products: Support Services

Budget Estimate: \$70,000

8. **Task VIII: Recommend Decontamination and Resettlement Strategies.** A Final Report by the Management Committee to the Republic of the Marshall Islands and Congress (expected in late 1990 or early 1991) will recommend appropriate actions for restoration, cleanup and resettlement of Rongelap Atoll taking into account dose, risk and environmental/socio-economic constraints, cost factors and current technology.

Testing of the plutonium mining method of cleanup developed by the Defense Nuclear Agency is proposed for Rongelap Island as part of the Phase 2 Comprehensive Study. It is anticipated that a small area of Rongelap Island would be used as a test plot. This element of the study would occur in the last two quarters and would be conducted under carefully controlled conditions by a competent, experienced contractor. Evaluation of the results of the test will be useful in preparing the final report of the Management Committee. The cooperation and assistance of the Defense Nuclear Agency would be desirable.

Work Products: Final Report to RMI and Congress

**Test Plutonium Mining Cleanup Technology
on Rongelap**

Budget Estimate: \$490,000

III. PHASE 2 STUDY ORGANIZATION

The Compact of Free Association authorizes an independent study of radiological and other issues related to the habitability of Rongelap to be performed by "a scientist or a group of scientists" under contract with the Republic of the Marshall Islands.

For many reasons the Department of Energy programs related to data collection and analysis have little credibility with the Rongelap people. Further DOE research efforts will likely be suspect as well. Therefore, an independent radiological and health survey, enhanced by other relevant studies, is necessary so that the data and the conclusions of the data will become an acceptable basis for resettlement and restoration decision making. Clearly, access to and use of the DOE data is essential to the success of any independent survey, as is DOE assistance and involvement. But control and direction of the study must be completely independent of DOE and its mission-oriented programs.

Rongelap Radiological and Health Study Management Committee (RRHSMC)

An appropriate institutional mechanism is necessary to set policy for the study and to make determinations on various scientific and technical issues. We recommend that any independent study be guided by a multi-disciplinary group to be called the Rongelap Radiological and Health Study Management Committee composed of approximately seven. Rongelap should also have a representative on the Committee nationally-recognized and highly credible individuals who will have the trust of the Rongelap people and the confidence of the public. This group will be charged with seven major tasks:

1. interviewing and hiring consultants to perform various aspects of the study;
2. reviewing and resolving various disputes regarding technical approaches that may arise and provide policy guidance and direction to the study staff;
3. assuring the credibility of the data;
4. sanctioning and officially reporting the results of the study and the relevance of its findings and conclusions as they pertain to resettlement and cleanup;
5. assuring the Rongelap people and the Republic of the Marshall Islands are kept apprised of progress and results of the study and its significance for them and for Rongelap Atoll;
6. providing testimony, as necessary, to appropriate Congressional committees; and
7. coordinating various aspects of the study to assure efficiency and effectiveness of the research effort. Such a group will also resolve disputes over use of various research techniques and will provide general guidance to the study team and their consultants.

Consideration should be given to having Committee and staff members obtain security clearances (if possible) to have direct access to DOE data they will need to review.

In the event any member finds it necessary to resign or becomes unable to serve, the remaining committee members, in consultation with the Rongelap Atoll Local Council and the President of the Republic of the Marshall Islands will move to appoint a replacement.

With the exception of any appointments who are members of the United States Government, or any state government, or who are paid employees of the Government of the Marshall Islands, Committee members will be reasonably paid for their participation, including reimbursement for travel and subsistence costs. Compensation should be on the basis of \$150 per hour, plus expenses. The committee will meet monthly in a location to be determined by the membership .

Staffing Considerations

The staff director will be responsible for implementing the various elements of the Phase 2 comprehensive study, for reporting to the Task Force periodically, for raising major data collection and research method issues to the Task Force for review and decision and for administering consulting contracts. The staff director is directly responsible for the progress and quality of the study and shall keep the Rongelap people, their council, RMI and appropriate Congressional committees fully informed on progress, problems, expenditures and other study related issues worthy of their attention.

It is estimated that the study will require a full time staff director, two staff assistants and an administrative secretary.

The staff director for the Rongelap Phase 2 study should have the following qualifications:

- o Complete confidence of the Rongelap Council
- o Independent from DOE programs (no contract history)
- o Some experience in radiological issues would be desirable
- o Experience managing major multi-disciplined study essential
- o Ability to focus full-time on managing study
- o Experience in managing a large budget
- o Contract management experience
- o Creative problem solving capacity
- o Ability to commit to up to two year term
- o Appropriate governmental experience

In addition, up to three administrative staff will be required, to be hired by the Staff Director after consultation and approval of the Rongelap Council and the Office of the President of RMI. One staff assistant will be necessary to assist the director in coordinating the various studies, assuring their timely completion and assisting in keeping RMI, Rongelap Council, the Task Force and Congress informed of progress. An accountant will be required to assure proper expenditure of funds, assure conformance with budget and audit contract performance. Finally, an administrative secretary will be required to assist in preparing reports, setting meetings, and preparing correspondence.

It will be necessary for the Staff Director to obtain a security clearance and other staff as necessary to review and utilize pertinent DOE data.

Office Location

Administrative offices should be located in the western or southwestern United States for easy access to Hawaii, Washington, DOE's Las Vegas and Lawrence Livermore offices and to the Republic of the Marshall Islands. Proximity to a major international airport facility is essential.

Consultants

Consultants will be needed to conduct several major aspects of the phase two study as follows:

- o **Radiological data collection and analysis.** The Committee will contract with a minimum of two independent scientists to accomplish this Task. Selection criteria will include:
 - Independence from DOE programs
 - credibility with the national and international nuclear community
 - demonstration of knowledge and experience in radiological assessment and dose analysis
 - demonstration of concern for the health of the Rongelap population vis a vis the scientific research opportunities this project afford
 - expertise and knowledge in determining plutonium dosage
 - familiarity with whole body counting for cesium
 - such other requirements that the Committee may require
- o **Dose Assessment.** Same criteria as used for radiological data collection and analysis.
- o **Baseline Health Survey of the Rongelap People.** The Committee will contract with a complete medical team to perform a full baseline health assessment on each individual in the Rongelap population. Criteria for selection will include:
 - Independence from DOE programs
 - corporation or multi-disciplinary team of doctors capable of spending two to three months in the Marshall Islands
 - medical team include a specialist chromosome damage and reproductive diseases
 - medical team demonstrate capability of performing a full physical and health assessment of each person in the Rongelap community, with particular emphasis on identifying symptoms or signs of radiation related diseases

- ability to provide all necessary medical equipment on site in Ebeye and Majato
- demonstrated ability to communicate adequately with the Rongelap people in their language or through an interpreter familiar with medical terminology who can assure the thoroughness and accuracy of patient interviews.
- o **Economic Impact and land value analysis.** The Committee will contract with a firm specializing in land economics and economic planning and development to perform this aspect of the study. The following criteria are suggested for selection:
 - experience in economic development and planning in emerging nations
 - proven track record in land/economic development
- Decontamination strategies and costs.**
 - Holmes and Narver Engineering, Albuquerque, New Mexico
- o **Transportation/island infrastructure needs.**
 - Holmes and Narver Engineering or P&D Technologies
- o **Sociological and Psychological.** Expertise in working with Marshallese or Micronesian populations will be required.

Study Timeframe

The study will require approximately 18 months to complete. Various tasks are estimated timeframe for their completion are itemized on the following time line chart:

TIMELINE
 PHASE 2 COMPREHENSIVE HABITABILITY STUDY
 JUNE, 1989 TO DECEMBER 1990

TASKS	3RD QTR 1989 JUN-SEP	4TH QTR 1989 OCT-DEC	1ST QTR 1990 JAN-MAR	2ND QTR 1990 APR-JUN	3RD QTR 1990 JUL-SEP	4TH QTR 1990 OCT-DEC
ORGANIZATION OF STUDY						
Hire core staff (Rongelap Council)	○					
Establish study office	○					
Management Committee--Organizational Meeting	○					
Management Committee/Staff orientation trip to RMI		○				
Solicitation of consultants		○				
Interview consultants		○				
Select and contract with consultants		○				
BASELINE HEALTH SURVEY						
Consultant orientation		○				
Meet with DOE/Brookhaven officials/request data		○				
Review & computerize Brookhaven data		○				
Prepare Personal medical files from DOE data		○				
Conduct examinations (Ebey & Majeto)		○ ————— ○				
Computerize and correlate data			○ ————— ○			
Prepare Personal medical files (DOE & New Data)				○ ————— ○		
Final report to management committee						△
RADIOLOGICAL SURVEY						
Consultant orientation		○				
Obtain and review DOE data		○				
Determine need for additional sampling		○				
Determine survey field Logistics		○				
Develop Cooperative agreement with U.S. for Logistical support		○				
Management Committee review and approval			○ ————— ○			
Soil, food, water marine sampling (Rongelap)			○ ————— ○			
Sample analysis and correlation with DOE data				○ ————— ○		

TWOONE
PHASE 2 COMPREHENSIVE HABITABILITY STUDY
JUNE, 1989 TO DECEMBER 1990

TASKS

3RD QTR 1989 JUN-SEP	4TH QTR 1989 OCT-DEC	1ST QTR 1990 JAN-MAR	2ND QTR 1990 APR-JUN	3RD QTR 1990 JUL-SEP	4TH QTR 1990 OCT-DEC
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BIOASSAY AND DIET SURVEY

Consultant orientation					
Obtain and review DOE data					
Identify blood, urine and liver sampling needs					
Develop diet questionnaire					
Determine additional infant/child data needs					
Determine Logistic needs (cooperative agreement with U.S.)					
Management Committee approval					
Field sampling (Ebeye & Majeto)					
Review of baseline health data					
Development of current and assumed diets					

DOSE ASSESSMENT

SOCIOECONOMIC STUDY

Consultant orientation	
Literature search/review	
Field trip to Rongelap & RMI	
Interviews with RMI & Rongelap Leaders	
Review of RMI economy/trends	
Review of existing conditions	
Identification of products/ services/employment needs	
Identification of revegetation needs	
Development of future economic prospects	
Final Report to Committee	

FINAL REPORT TO RMI AND CONGRESS

Prepare Risk Assessment	
Staff draft to Management Committee	
Final approval of Report	

IV. UNRESOLVED HEALTH, RADIATION, AND HABITABILITY ISSUES

In accordance with the provisions of the Compact of Free Association, the Work Plan for a Phase 2 comprehensive study is specifically required to completely study **"radiation and other effects of the nuclear testing program relating to the habitability of Rongelap Island."**

The Compact establishes "safety" and "habitability" as policy goals for the Rongelap people. It mandates a two-part review. First, the Compact directs that radiation related issues be examined. Second, the act then directs that, in addition to radiation, "other effects" from nuclear weapons testing program relating to habitability be fully considered to assure that Congressional, Republic of the Marshall Islands, and Rongelap decision-makers will have a full understanding of the extent of the range of programs that will be necessary to achieve habitability. While **"other effects"** is not defined in the statute, one can readily assume that broader health, sociological and economic issues are contemplated here, since it is presumed that any resettlement program would resettle the Rongelap population on their atoll only when all parties can be reasonably assured that

- o the atoll is safe for human habitation;
- o an available food supply for a balanced diet is assured, at least to the extent that such was available prior to the Bravo blast; and
- o that the livelihood and industry of the Rongelap people will not be adversely impacted by remaining radiological issues or by limitations on the use of food or fibre due to remaining contamination.

With these objectives in mind, the elements of the Phase 2 Work Plan discussed in this section will propose study of outstanding radiological, health, sociological, psychological, economic, environmental and other factors that have a bearing on habitability and which the Rongelap people believe are important to the resettlement of their homeland.

BASELINE HEALTH SURVEY

One of the major concerns of the Rongelap people is the general health of the population. Memories of the radiation effects suffered by the Rongelap people in the early years after Bravo and fears about the future of their health and that of their children dominate their thinking. They feel there are many unanswered questions concerning what they can expect will happen to their bodies, the bodies of their children and those yet unborn as a result of their contact with radiation. They worry about cancer, leukemia, birth defects, and a myriad of other disorders that they know are associated with exposure to radiation.

The Department of Energy, through their contractor Brookhaven National Laboratory in Upton, New York, is statutorily responsible for the health of the exposed Rongelap population. This program is characterized by DOE officials as a "clinical" program which is primarily responsible for the treatment of those individuals in the Marshall Islands who have been exposed to radiation from the U.S. nuclear weapons testing program. "We provide medical care," said one Brookhaven official, "but we are not providers of medical care." A fine but, nevertheless, significant distinction. In short, Brookhaven does not consider itself the family doctors for individuals in the Rongelap community, but views the Four Atoll Health Program and other Marshall Islands administered programs as exercising that responsibility. DOE is statutorily responsible

for treating only those exposed individuals. Brookhaven doctors do not feel comfortable characterizing the general state of health of the Rongelap people. (During the March, 1989 meeting between Rongelap, RMI and DOE officials, Dr. William Adams declined to characterize Rongelap health and said Marshall Islands health authorities are better able to answer the questions.)

Over the years DOE and its predecessor agencies (Atomic Energy Commission and the Energy Research and Development Administration) have amassed considerable personal health information on the exposed group and the Rongelap comparison group, (a group of individuals who were not on the Rongelap Atoll at the time of the Bravo blast, but who have voluntarily agree to submit, as a basis for comparison, to the regular health examinations given the exposed population). These examinations occur every 2 years. Children and others not in the exposed or comparison groups are treated as time will permit; however, no comprehensive effort is authorized by law nor has been made to fully examine regularly the entire Rongelap population.

A recent effort was made by The International Institute of Concern For Public Health to learn more about the health conditions of the Rongelapese. In 1988, a private physician, Dr. Brenda Caloyonnis went to the Marshall Islands to document health problems generally; no attempt was made to discriminate between radiological health effects and other health problems, because it is difficult at this time to make such a determination. This assessment looked at approximately 297 children, 113 male adults, and 134 female adults. Urine samples were taken to reveal protein and sugar levels in the body. Blood tests were not done. This was not a thorough baseline health study, but was meant to provide an indication of the general health of the population.

The study sought answers to several key questions:

1. Has the general health of the Rongelap people been improving, deteriorating or remaining stable over the last 35 years?
2. How would Rongelap people's health be affected if they moved back to Rongelap Atoll in its present condition?
3. Is there any indication of continued residual health damage in the Rongelap people exposed to high levels of radiation March 1, 1954 and their offspring?
4. Is there any indication of radiation related health problems in Rongelap people who were not in the 1954 fallout, but who lived on Rongelap Atoll after 1957?

The study has revealed the population is in generally poor health and there are particularly troublesome health problems among the Rongelap children. The study also concludes that "reproductive losses in the Rongelap women appear radiation related".

In her testimony before the House Appropriations Committee, Dr. Rosalie Bertell reported that the reconnaissance survey found each Rongelap child has an average of 1.7 major health problems. The survey also shows a high incidence of diabetes, gum disease, downs syndrome and skin disorders among the general population.

Brookhaven officials disagree that the health of the Rongelap people is worse than it was before Bravo. They report that their data does not show a decrease in survival of

the population as a result of radiation exposure. They argue that the likelihood of contracting cancer is greater in the U.S. than among the Rongelap population, and conclude that there is no evidence of increased cancer in the population. The same conclusion is reached with regard to birth defects and other major diseases such as diabetes.

Yet Brookhaven doctors do not have complete health records on all the Rongelap people and those records are not generally available for review and analysis. (They are considered proprietary and are available only at the request of the individuals). Therefore, with the exception of the recent study done by the International Institute for the Concern for Public Health, health statistics have not been available.

Another health issue concerns blood samples taken by Brookhaven over the years and what they may indicate with regard to future cancer risks. Blood samples can indicate abnormalities in the blood, and that a review of the data is necessary to determine whether or not there are signs of problems. The blood tests were taken regularly by Brookhaven each year and hand recorded, but evidently nothing was ever done with the information and it was never computerized. Computerization of this data will provide important information for the Rongelap people and will indicate whether major health problems, such as certain forms of cancers, can be expected among the exposed population.

The concern over the health of the Rongelap people and their children is undoubtedly a remaining issue that requires attention at the initial stages of a Phase 2 study. No one disagrees that a complete health record of every man, woman, and child that intends to resettle Rongelap does not exist, although DOE says it is equipped to perform such a task if so directed by Congress.

A baseline health survey conducted by an independent team of doctors and specialists will serve two purposes. First, it will provide the Rongelap people with specific information about the current state of their health and the health of their children which may be useful in individual decisions about whether to accept any additional risk from radiation exposure that may result from resettlement on Rongelap Atoll. Second, a baseline health survey will be useful in determining the general health of the population-which no one is willing or capable of characterizing at this point. This will be important data in resettlement planning, risk assessment, and, ultimately, clean-up strategy for the Atoll.

Therefore, P&D Technologies recommends that:

1. **A complete physical and health assessment of each man, woman and child be conducted during the early stages of the Phase 2 study by an independent team of physicians and specialists. This health assessment should include, among other things, the taking of blood samples to develop additional chromosome and cytogenetic data on each individual. This team should be available at Ebeye and Majato (and, if necessary Majuro) for a length of time necessary to fully examine all of the members of the Rongelap community.**
2. **Blood chromosome, physical examination data, and surgical data accumulated by Brookhaven National Laboratories be released to the independent health contractor as necessary for examination, computerization and analysis.**

DOSE ASSESSMENT OF THE RONGELAP POPULATION

Until now, the Department of Energy basis for determining whether Rongelap is safe for human habitation has been limited almost exclusively to an assessment of radiation dose and the extent to which such determination is within DOE radiation standards. The Rongelap Reassessment Project reviewed the DOE data and conclusions in an effort to determine whether the data and conclusions could adequately support a decision to resettle the Rongelap people on Rongelap Island. The reassessment did not assess the safety or habitability of the entire Atoll or the neighboring atolls of Rongerik or Ailinginae, so no assessment exists on the other 60 islands. Also, notwithstanding the fact that the Report concludes that Rongelap Island is safe for resettlement of the adult population, it identifies many areas where additional data and analyses are needed, such as in the areas of radiation effects on infants and small children and plutonium and transuranic dose assessment, among others. The discussion generated since the Reassessment Report was published has led to the emergence of several additional unresolved issues.

P&D Technologies' review has identified seven major unresolved issues relating to the dose assessment of the Rongelap people:

1. Radiation dose from cesium and strontium.
2. Diet assumptions in dose assessment.
3. Plutonium dose.
4. Average vs. individual dose.
5. Past and future dose.
6. Child and infant dose assessment.
7. Appropriate standards and guidelines.

These issues represent areas of significant disagreement between the Rongelap Atoll Local Council and the Department of Energy. Some of the issues were identified in the Rongelap Reassessment Report. Others have been identified during the preparation of the Phase 2 Comprehensive Work Plan.

With the exception of the issue of applicable radiation standards, the unresolved issues involve either disagreement over assessment assumptions, dispute over methodology or adequacy of data.

In approaching the dosimetry of the Rongelap people, scientists cannot ignore the fact that they are dealing with a population that has been exposed to varying degrees of radiation. Unlike the people of Bikini and Enewetak, who were removed from their atolls to prevent their exposure to radiation from nuclear testing, the Rongelap people were heavily exposed in 1954 to Bravo's fallout. Also, unlike the people of Bikini and Enewetak, this heavily exposed population and its decendent were relocated to their contaminated Atoll in 1957 and lived, ate, worked and played in this environment for almost three decades before abandoning it out of fear for themselves and their children. Enewetak has been the subject of a comprehensive clean-up effort and its people have been resettled. The clean-up of Bikini is currently underway. In both cases unexposed populations are being resettled to decontaminated atolls. This is not to downplay the significance of the sacrifice and hardship that the people of Bikini and Enewetak have endured. However, it does emphasize the unique problem of Rongelap.

Because the Rongelap people have suffered numerous, well-documented effects from radiation, they are particularly sensitive to the thought of being exposed to more radiation. Therefore, the Department of Energy released its 1982 study of the radiation effects on the Northern Marshall Islands containing a map (see map reproduced in Appendix C) showing radiation levels at Rongelap to be, in many instances, as high as levels on Enewetak and Bikini (deemed too high to sustain safe habitation). Moreover the Rongelap people recognized that they were living in the midst of the higher values shown on the map and became extremely concerned. Since then, the Rongelap Council and other leaders have been attempting to obtain a clear understanding of the effects of radiation on their people, the extent to which their Atoll needs to be decontaminated and what should be done to assure the future health and safety of the population if resettlement occurs.

From the day the Rongelap people were removed from their atoll after Bravo and taken for examination and treatment on Kwajalein, the U.S. Government began to keep records on dosage and exposure, both of the general population and on affected individuals. The Rongelap Reassessment Report (p.13) summarizes those initial effects as follows:

Consistent with a whole-body dose of 190 rem (over two days), two thirds of the Rongelap group experienced nausea, 10% with vomiting and diarrhea, which cleared within three days or so, and all showed depressed white-blood-cell counts (Cronkite et al, 1956). As a result of the skin dose from physical contact with fallout, about 70% developed skin lesions of widely varying severity after a latency period of two to three weeks. Most of these were to heal successfully but a few developed significant scarring. There were no deaths within 60 days of exposure.

The most "significant" part of the initial exposure produced no immediate signs or symptoms. A half-dozen thyroid-seeking radionuclides entered the body through fallout-contamination of food and water. Over the course of the following weeks these iodine and tellurium radionuclides delivered doses that eventually caused thyroid hypofunction and the appearance of thyroid tumors.

According to Dr. Kohn the original dose estimates made were too low, so the extent of thyroid disease in the population was unexpected, which resulted in a revision of the thyroid dose, first in 1956 and later in 1964.

Therefore, thyroid difficulties were the first perceived long-term impact on the health of the Rongelap people. As a result, many of the 85 people who suffered exposure on the atoll from Bravo, had their thyroid glands removed.

Bravo was one of the first hydrogen bombs detonated by the U.S., in fact, the largest of its kind. It generated a variety of radionuclides which scientists and doctors had little or no experience in assessing their short and long term effects on humans.

The Bravo test posed new dosimetry problems, only vaguely sensed before. Owing to the gigantic energy-yield at ground level, great quantities of coralloid radioactive material were generated (Hiroshima and Nagasaki had involved high air-bursts): 142 radionuclides were involved whose radiations and rates of decay varied greatly, and whose eventual effects depended on the weather conditions and the living

habits of the exposed population." (Rongelap Reassessment Report, p. 13 emphasis added)

The Bravo radioisotopes and their effects became the ultimate focus of the Brookhaven National Laboratory Medical Division's Marshall Islands Medical Program (later transferred to Brookhaven's Safety and Environmental Protection Division). Brookhaven scientists and doctors established a periodic monitoring program in 1957 that continued uninterrupted until last year.

Radiation Dose from Cesium and Strontium

Brookhaven National Laboratory measures the amount of radionuclides in the human body at a given time in urine, and uses the data to estimate the body burden and, thus, the dose. Its original focus was primarily on cesium and strontium.

Brookhaven uses equipment, called **whole body counters** to measure cesium radionuclides in the human body. Measuring cesium is of particular importance in dose assessment since, according to the Rongelap Reassessment Report (p. 32) "it accounts for 95% of the dose."

Analysis of urine samples was utilized by Brookhaven National Laboratory to determine the strontium-90 dose.

The radiological status of the Rongelap Atoll environment, on the other hand, became the responsibility of Lawrence Livermore Laboratory in Livermore, California. Lawrence Livermore is measuring radionuclides in the environment and food by assuming certain diet models. Their scientists' primary responsibility has been to conduct radiological surveys of soil, plants, food and water which would be useful in determining the extent of contamination on the Atoll. Unlike Brookhaven, the Livermore scientists approached cesium and strontium dose assessment by attempting to determine the amount of radiation entering the body through various pathways, such as inhalation and ingestion, and then applying various exposure factors to calculate dose. **Diet models**, in which certain assumptions were made about what the people on Rongelap might eat, are a critical aspect of this analysis.

Therefore, both National Laboratories have been responsible for developing dose assessments for cesium and strontium, each using a different methodology, and both Laboratories developed dose assessments for these radionuclides during 1978 prior to the publication of the 1982 DOE Bilingual Radiation Report. However, according to the Rongelap Reassessment Report, only the Livermore data was used in the conclusions contained in the 1982 DOE Bilingual Report.

Through their research efforts, DOE laboratories have amassed considerable data on individual exposure to cesium and strontium. The most recent analysis of DOE data presented to RMI and Rongelap elected officials and their consultants at a meeting at Lawrence Livermore Laboratory in early March, 1989 support their conclusions that the expected dose from these two elements are well within the DOE radiation standards.

While the basic data and methodology used to quantify cesium and strontium exposure are not in dispute, the assumptions made by DOE regarding diet have been questioned. The diet model directly affects the dose estimate, and the more realistic the model, the more accurate the dose estimates.

3. **Additional soil water and marine samples be collected on Rongelap Atoll as necessary to augment and complement the existing DOE data base. In doing so, sufficient collection of samples should occur on all islands around the lagoon to develop parameters for cleanup and resettlement.**
4. **A whole body counter be established in a permanent location in the Marshall Islands accessible to the study team and to the general Rongelap population to facilitate data collection and to minimize travel difficulties.**
5. **Individual dosage data be correlated as closely as possible with information obtained in baseline health surveys to determine the health risk associated with resettlement of each individual.**

Diet and Dose Assessment

Understanding dietary needs is a key factor in cesium, strontium and plutonium dose assessment. According to a document entitled "Environmental Monitoring, Research and Dose Assessment Program" prepared by DOE in November, 1980 (hereinafter referred to as The 1980 DOE Work Plan),

A critical parameter in the dose models is the average annual (or daily) intake of local subsistence foods. The pCi intake of all radionuclides is directly related to the amount of contaminated food products consumed. Therefore, it is most essential to have accurate information on the average diet and consumption patterns at each of the atolls (p.32).

The 1980 DOE work plan states that dietary information developed for one atoll may not be appropriate for another. Therefore, an assumed diet that is specific for the Rongelap people is required.

There are two aspects of the diet problem. First, the average Rongelap diet as it exists today must be understood. Second, certain assumptions must be made regarding the kind of diet that can reasonably be expected for the population upon resettlement. The nature of the diet may be directly related to the comprehensive nature of atoll restoration and clean-up. For example, if the clean-up is limited to Rongelap Island only, and the gathering of traditional foods from other islands is prohibited due to contamination levels, then imported foods will undoubtedly play a larger role in the Rongelap diet for some time to come. However, if the entire Atoll is subject to decontamination then some traditional foods may play a larger role in the diet than would otherwise be the case.

The Rongelap Reassessment Report (p. 65) details what has been done to date to determine the diet of the Rongelap people for purposes of radiological analysis:

The major uncertainty in estimating the dose is the diet--no one knows exactly what it is. Two efforts have been made to delineate it. The first by Naidu et al (1980) (BNL 51313) was based on living experiences over the years on various Northern Marshallese Atolls and clearly demonstrated the effects on living patterns on it. Rongelap fell into their B class, one in which there was a low availability of local foods (excepting fish), overpopulation, and a good supply of imported foods (supply

boat comes regularly, say, every three weeks). Naidue et al reported the quantiles of food prepared, but emphasized that they did not know how much was eaten. In any event, Roblson and DOE-1982 used this estimate as the maximum level of consumption for a population.

The MLSC diet was elaborated by M. Pritchard of the Micronesia Legal Services Corporation in 1979 when he visited the Enewetak people for 2.5 weeks on Utirik Atoll (Roblson et al, 1982). His diets assumed that the supply ship came regularly, making it possible for the people to eat relatively large amounts of imported foods (rice, flour, sugar, canned goods, etc.), or that the ship did not come at all. Roblson selected the adult female subgroup of the population for calculation because its consumption was greatest. DOE-1982 took this calculation for the minimal level of contaminated food consumption....

In summary, then, DOE-1982 used the Naldu type B community diet for its dose calculations. When it wished to indicate a range, it used both the type B community (high) and the MLSC diet (low)....

These two assumed diets used by DOE are specified in Appendix E, excerpted from the Rongelap Reassessment Report.

The Rongelap Reassessment Report, concludes that significant errors occurred in the 1982 DOE report in which "local food" and "mixed food" diets were presented incorrectly. According to the report "DOE - 1982 (the Bilingual Radiation Report) stated that the diet on which its reported doses were based consisted only of local foods from Rongelap Island. That statement is incorrect." Dr. Kohn went on to state that "the (mixed food) diet involves the use of imported foods brought in on a regular basis by supply ship to supplement local produce. Without such imports, the doses would be higher."

To further complicate matters, the food program, on which the Rongelap people currently depend, expires within 18 months and there is no assurance that it will be extended beyond that time by Congress. Even if it is extended, an assumed diet must take into account the chronic tardiness of food ships and alternative foods that would be consumed should the ships not arrive on time.

Therefore, P&D Technologies recommends that:

6. **Dose assessments using both the mixed food and local food diet models will be developed utilizing, where appropriate, DOE data.**
7. **A determination of the current diet of the Rongelap people and realistic diet options keyed to various levels of clean-up at Rongelap Island, Rongerik and Ailinginae be developed. If dependence upon imported food to be brought by ship is to support a major element of the diet, then the history of the frequency and reliability of these supplies should be taken into account, and appropriate adjustments made. This aspect of the study should be done by qualified dieticians who can ascertain the diet needs and expectations for the entire population, infants, children and adults, and people with health-restricted diets.**

8. Determine the length of time the Rongelap population will be expected to depend heavily upon imported food for their diet should resettlement and clean-up occur.
9. The diet models should be subjected to appropriate sensitivity analyses.

Plutonium Dose

One of the major issues arising from Dr. Kohn's reassessment study is the concern over exposure to plutonium and other transuranic¹ elements. Prior to Dr. Kohn's study, the Rongelap people were not aware that there could be a risk related to levels of plutonium on the atoll, even though DOE officials have been studying the matter of elevated levels of plutonium in urine for almost 15 years. While plutonium was mentioned in the 1982 DOE Report, "The Meaning of Radiation" it was not identified as a major element for concern in the report, and plutonium was included in the calculations for average radiation dosage the Rongelap people could expect to absorb over a 30 year period (1978-2008) of analysis.

The International Atomic Energy Agency (IAEA) has ranked plutonium as the most radiotoxic element. DOE data demonstrates that soil from Rongelap Island has about 430 times the concentration of plutonium and americium than the average for the Northern hemisphere. Islands in the northern end of the atoll, have levels of plutonium up to 10 times higher than Rongelap Island. Therefore, plutonium is of crucial concern to the Rongelap people and is critical to any complete baseline determination of previous exposure and its implications for resettlement and clean-up.

DOE contractors are currently preparing a radiological assessment for Rongelap that was not available at the printing of this work plan. However, during the March 8 meeting between DOE officials and representatives and consultants to Rongelap Council, some aspects of the preliminary conclusions were discussed. This presentation indicates that considerable study and analysis has been given to the plutonium problem in the months since the Rongelap Reassessment Report was published. In that same interim period, consultants for the Rongelap Local Government Council have developed a comprehensive analysis of the available DOE data, and a written and oral presentation of that material was made by Bernd Franke to the meeting participants. No substantive discussion occurred on the issue that was helpful in resolving the plutonium question.

The steps that are employed in estimating doses from plutonium in urine are:

- o Take multiple samples from all exposed individuals.
- o Exclude the possibility of contamination from plutonium bearing dust.
- o Determine plutonium concentrations with precise method.

¹

Transuranic elements are chemical elements with atomic numbers greater than that of uranium as classified in the table of elements. Transuranic elements have an atomic number greater than 92 and are radioactive. Plutonium-239, is a transuranic element and has a half-life of 24,000 years. Other transuranic elements include americium, curium, californium and neptunium.

- o Determine the time period during which plutonium entered the bloodstream.
- o Use excretion functions to estimate the urinary output of how much plutonium entered the bloodstream.
- o Estimate radiation doses based on estimate of plutonium intake.

Two methods that have been employed by DOE to determine the plutonium doses in urine, and considerable disagreement exists among U.S. Government scientists as to which is the most reliable. The significance of the disagreement is that estimates for daily intake of plutonium on Rongelap vary widely, making determinations of body burdens for plutonium very uncertain, if not totally unreliable. According to the Rongelap Reassessment Report,

For Rongelap, diet and urine methods are in frank disagreement. The Livermore diet method finds the daily intake of plutonium-239 to be .18 pCi/d....

On the other hand, the current analysis of urine at Brookhaven gives the plutonium-239 excretion values which range from less than 1×10^{-5} to about 5×10^{-3} pCi/d. **These correspond to a range of intake from less than .07 pCi/d to about 38 pCi/day.** (emphasis added)

Dr. Kohn reports that over 270 samples of urine were analyzed until work was stopped due to lack of funds. Of these, he used data from 104 samples measured by Brookhaven with the fission track method. Sixty-two of these samples are above the detection limit, and therefore became the focal point for evaluation.

The **fission track method**, developed by Brookhaven scientists, uses a sophisticated three step process that produces a more sensitive determination of the levels of plutonium in the urine than previous methods employed before. It measures the tiny amounts of plutonium in the urine that result from intake of Plutonium into bloodstream. However, the system is only as good in determining dose as the assumptions that are made about the ratio of intake to excretion.

When urine analysis is employed to identify the plutonium dose, several excretion formulae are available to scientists to determine final results. Here, as well, there is significant disagreement over the correct approach and the results of the three formulae vary widely. These functions (for example Jones, Durbin and Moss, all named after the scientist that developed the formula), make difference assumptions concerning the ratio of intake of food compared to the volume of urine excreted.

None of these functions are intended to be used for interpreting data for infants and children.

This report will not attempt to interject into the debate or make any judgments as to which should be used in any Phase 2 study. Until there is a universally recognized formula, the Rongelap people believe that the method should be employed which is the most conservative from a human health risk standpoint, or which results in higher, rather than lower, dosages.

A member of the Rongelap Reassessment Project, Bernd Franke, team concludes that the various processes for determining plutonium dosage vary widely. In his August 16 comment on the Rongelap Reassessment Report, in which results from the Moss function were employed, when he observed,

At the very least, in light of the imprecision of the data, the uncertainty of dose prediction is a factor of two. It therefore appears that the more appropriate way to present the data would be to indicate the range based on both, the "Moss and the "Jones" factors. Then the range of plutonium dose would be 0.005 rem to 5.9 rem whole-body. It is well possible that the dose range is even larger. We will only know after careful multiple samples and their thorough analysis and interpretation.

Until the debate is resolved, the Rongelap Council prefers an approach that demonstrates the full range of risks that emerge from analysis of the data.

Both DOE and the Rongelap officials agree that urine sampling procedures should be more thorough and comprehensive and that more stringent sampling procedures should be employed to prevent contamination of samples. To the extent that existing DOE data can be useful in determining plutonium radiation doses in individuals, they should be used. But if any doubt exist regarding the possibility of contamination of existing urine samples due to improper sampling controls or faulty techniques, new urine samples should be collected and analyzed in order for the plutonium exposure of each Rongelap individual to be recorded and understood.

DOE has indicated that it has already made improvements in its sampling technique to prevent dust contamination, and it plans to collect new urine samples in the summer of 1989.

The plutonium issue is perhaps the most difficult issue to address in the Phase 2 Work Plan, and the issues involved in making a plutonium dose assessment are far more complex than we have been able to discuss here. Clearly the Brookhaven scientists should be requested to assist the Phase 2 Work Plan team, particularly in making provisions for use of the fission tracking reactor and associated facilities. Since these facilities are secure areas and are off limits to the general public, special provisions will be necessary for members of the study team or its consultants to observe while urine samples are being tested. Nevertheless we believe it is essential that this cooperation occur in the interest of maintaining the independence of the study and to preserve its credibility with the Rongelap people.

Therefore, we recommend:

10. **Develop a plutonium and transuranic research program for Rongelap that will:**
 - o **Take multiple urine samples of all previous residents of Rongelap Atoll.**
 - o **Perform analysis under stringent and independent quality control.**
 - o **Determine distribution of transuranics in soil at Rongelap Atoll.**
 - o **Determine micro-distribution and particle sizes of transuranics in soil.**
 - o **Evaluate the effect of behavior of infants and children on increased plutonium dose (crawling**

on the ground, ingestion of soil etc.).

- o Determine concentration of transuranics in prepared food.
 - o Evaluate potential uptake of transuranics through wounds and skin.
 - o Examine the uncertainty of dose estimation process, and develop an acceptable assessment methodology.
11. The Management Committee review excretion functions available for determining plutonium body burden based on levels found in urine. An excretion function that would be reasonably conservative for the Rongelap people should be employed.
 12. The DOE be requested to provide all sampling and analysis information and assistance to the study team for its review and assist as necessary to determine the accuracy of the Phase 2 plutonium analysis.
 13. The Phase 2 study team enter into an agreement with the DOE and Brookhaven National Laboratory to employ its fission tracking system in conducting analysis of urine samples for plutonium, and that appropriate procedures be established to protect the independent nature of the study.

Average vs. Individual Dose

Determination of the radiation dose of the Rongelap people is a key element in determining the further risk of the population as a whole (and that of each individual) if resettlement on Rongelap occurs, with or without cleanup. The Rongelap people believe that the DOE data on dose is probably adequate for some individuals as far as iodine, cesium, and strontium are concerned, but not for the entire potential resettlement population. On the other hand, the data on plutonium dose is deemed inadequate and inconclusive.

Further, the various presentations of the data cause concern, particularly when they are expressed in **average** or **mean** terms, as has consistently been the case in the DOE assessment work. The Rongelap people believe that the risk of each resettled person should be fully understood, so that individuals who could be at greater or unacceptable risk can determine for themselves whether they should risk returning.

The 1980 DOE Work Plan for the Northern Marshall Islands (p. 10) indicates that some individuals can have doses greater than the reported mean dose values:

The basic rationale for the current DOE environmental monitoring research and dose assessment programs in the Marshall Islands is to develop a reliable data base for estimating radiological doses to populations on the northern atolls. This data base also provides a basis for information on resettlement options at Bikini and Enewetak Atolls and provides the necessary basic research data to allow predictions of dose beyond one point in time.

The data for the various parameters in the dose models are available as a range of values; **a mean value for each parameter is determined from the available data.** As a result, the average dose calculated from the parameters will represent a range of doses determined by the distribution of the data for each of the model parameters. **Therefore it is possible for a person to receive a dose which exceeds the average dose and for this reason it is essential to develop monitoring and research programs to refine the data base for making these dose assessments (emphasis added).**

The 1980 DOE Work Plan reports that dose assessment programs prior to 1968 "were not directed toward providing an adequate data base upon which predictive dose assessments could be made", and were focused more on matters of "general academic interest." Personnel monitoring, or body counting and urine bioassay analysis, had two stated goals that still apply today:

- 1) providing documentation that the doses and body burdens being received are within range after resettlement occurs, and more importantly for our immediate purposes,
- 2) providing direct data on individual body burdens of Cs 137 and Sr 90 radioisotopes to assist in determining **precise** individual risk associated with additional radiation exposure.

Precise individual risks have not been determined for the Rongelap people, rather dose assessments have led to a determination of the average dose of the entire population.

The risk of each resettled persons should be fully understood, so that each individual at greater or unacceptable risk can judge whether he or she can risk returning. This concern is of considerably greater relevance to the people of Rongelap than for either Bikini or Enewetak populations--where both communities having been removed for their respective Atolls have not been exposed to radiation and thus did not have individuals already "at risk".

A comprehensive approach to determining dose, focused on identifying individual exposure, is needed to arrive at dose calculations that will have credibility with the Rongelap people.

In the absence of such individual data, the final overall dose assessments are inadequate as a credible basis for land use and resettlement decisions.

Therefore, we recommend that the Phase 2 study:

14. **Analyze the existing DOE data on dose for each individual planning to resettle Rongelap Atoll and initiate a renewed testing program to effect accurate individual dose assessments.**

Past and Future Dose

The distinction between the radiation dose previously received by an individual and that which may be received in the future has been blurred in previously done whole body dose assessments. Also, previous dose history is somewhat discounted in determining risk. The Reassessment Report demonstrates this:

...But what about the influence of the past? The Rongelap residents exposed to the Bravo shot received an acute dose of 190 rem in 1954; during 1957-78 they received a chronic dose of 3 rem. My opinion is that the addition of these past doses of something like 3 rem during the next 30 years will not appreciably increase detectable health and genetic risks in a way that should preclude return to Rongelap Island.

The Brookhaven data contained in the Rongelap Reassessment Report shows the average annual external exposure rate for the Rongelap people. The data provides estimates each year for cobalt, cesium, zinc, strontium and iron radioisotopes (see Appendix F). The data calculations begin in 1957, three years after the Bravo blast and the year the Rongelap people were returned to their Atoll, and extends to the year 2009. Data was calculated to that point because the period for projecting the 30 year dose accumulation in the report was from 1978 (the year of the DOE radiological survey was completed for inclusion in the 1982 report) to 2008.

There are three major concerns about the Brookhaven table and the 30 year period it uses to predict dosage. First, the years 1954 through 1957 are omitted. While it is true that the Rongelap people were not residing on their Atoll during this three year period, they were there for the first three days after the Bravo Blast and received an estimated 190 rem from the initial fallout. Second, the group of adults and children that lived on Rongelap Atoll at some point between 1957 and 1985 have some previous exposure history that is only partially accounted for in the Brookhaven 30 year dose that begins in 1978. Finally, plutonium and transuranic doses are not included, and they could be a major contributor to a 30-year dose assessment.

The DOE 30 year dose estimate for the Rongelap population is complete for the majority of the population and is useful for a determination of the acceptability of risk. The DOE data and analysis assumes that the exposure never occurred and that 1978-2008 dosages were affecting an unexposed population. We recommend:

- 15. Individual dose assessments should fully account for all previous radiation exposure experienced by members of the Rongelap population including the initial exposure from the Bravo blast. Dosage should cover periods of time that more realistically relate to the Rongelap experience, such as 1954-1984.**

Child and Infant Dose Assessment

No one can question that the United States Government has a strong commitment to the protection of the health of children. Many Federal policies programs and laws are specifically aimed at protecting children from poor health and physical harm. Therefore, it is assumed that concern for children must be an essential element in the resettlement decision-making and the assurances contemplated in the Compact of Free Association.

The Rongelap People made the difficult decision to abandon their Atoll in 1985 primarily over concern for the health and welfare of their children. Rongelap families are large and there are many children. And children are likely to be affected to a much greater degree than adults from exposure to radiation. Since there was no pertinent data on infant and child dosage, Dr. Kohn established his own data gathering program using Peace Corp volunteers to collect information from observations and interviews in the homes of Rongelap families. Dr. Kohn states that "It is not claimed that these results are definitive. Nonetheless, I believe that these data do provide the very least significant orientation to the problem". The reports of his study have been negative, at least thus

far. Dr. Kohn recommends that the study of diets for infants and small children be extended.

Dr. Kohn cautioned that the lack of data on the radiological effects on infant and children necessitates caution in drawing conclusions about resettlement. DOE assumptions and data are aimed at assessing risk for the average adult. Children are more likely to come into direct contact with certain types of radioisotopes--particularly plutonium--due to their more frequent contact with dirt, dust and their physical and physiological processes. However, data gathering is "much more time consuming than foreign consultants might suppose."

In our estimation the determination of the habitability of Rongelap for children should be the paramount consideration for decision-makers. Once that determination is made in the affirmative, then we have something with which to work. A determination that Rongelap is safe for adults (even if the Rongelap People were to agree with it) is not particularly useful information in the absence of knowing how resettlement of families (and under what condition) will be affected.

Many estimates have had to be made in determining risk for children upon resettlement. Different variables must be considered in any radiological assessment. For example, Dr. Kohn's Peace Corps researchers compiling data on infant diet found that the length of time a mother might breast feed could extend up to 1 year. Kohn concludes that during that time "a 'safe' mother should be associated with a safe baby". However, this may not be true if the baby is not allowed to sit and play in the dirt and is not otherwise protected from radiological factors that could increase risk. According to Bernd Franke, young children play in dirt and therefore may be more susceptible to exposure to transuranics than adults. While playing away from their parents watchful eye, children may eat local food that should not be consumed due to possible contamination from uptake in the food chain. Also, radioisotopes entering the body have a longer lifespan within which to affect harm. And finally a correction factor must be applied for children up to 10 years to adjust for smaller body size and quantity of ingestion vs. excretion of radioisotopes.

Data availability on the impact of transuranics (plutonium-239, 240 and americium-241) on children is nonexistent, so Dr. Kohn had no choice but to estimate the impact of these radioisotopes. His assumptions for estimates are:

- (a) For ingestion, suppose that infants and children eat as much of the transuranics as do adults. Taking the worst case of no supply ships for the entire years, so that only locally produced foods are consumed, Livermore now estimates an adult intake of 1.8 pCi/d (Ref. Robison).

This results in a committed effective dose equivalent of .028 rem, of which not more than .001 would be received in the first year to due assumed breast feeding. An inhalation dose is assumed as well, which is the same as the assumed adult exposure-- .024 rem--which results in a committed whole-body dose of .009. Adding the ingestion dose to the inhalation dose, Kohn arrives at a total transuranic dosage of .037, with no more than .02 absorbed in the first year.

All this may in fact be accurate; however, the problem is that the Rongelap people must accept these assumptions and estimates before they are comfortable with the dosage statistics. In living day to day, many uncontrollable variables (differences in family customs, lifestyle, etc.) could render the estimates useless a real determinants of infant risk. It also, ignores the troublesome problem of children coming into contact with potential hotspots if resettlement precedes clean-up, which could make the estimates meaningless in such cases.

We believe the current method of estimating the dosage for children simply requires too much of a leap of faith on the part of the Rongelap people that the unassumed will not happen. In the case of children, we should make every possible effort to take the guesswork out of the risk assessment process. Therefore, we recommend that

16. **The recommendation contained in the Rongelap Reassessment Report to "extend the study of infant diets and those of small children" be implemented.**
17. **A "worst case" scenario be used to determine the risk for infants and small children and that the assumptions used in any radiological assessment model for children be subjected to thorough sensitivity analyses. Every effort should be made to eliminate the prospect for any child being subjected to radiation unnecessarily and should assume that Rongelap children, like other children around the world, will be able to move freely and manipulate and interact with their environment.**
18. **An appropriate excretion formula be developed to analyze plutonium in children.**

Radiation and Cleanup Standards

The Department of Energy establishes standards for radiation exposure for individuals. Since 1960 it has relied on a single consistent guideline which has been the basis for their radiological work in the Marshall Islands. The standards are currently in the process of being revised and strengthened.

Compliance with the standard does not mean that a risk-free situation exists, nor that Rongelap will be safe for habitation if dose estimates do not exceed standards. It means that an individual is within an acceptable range of risks. In response to questions posed by Congressman Ron deLugo, DOE stated that it "has quite consistently avoided terminology using the word 'safe'. We (DOE) avoid the term because in current usage it has taken on the connotation of 'risk free', whereas it cannot be said with certainty that even the very low levels at Rongelap are completely without risk."

DOE officials have told the Rongelap people that these standards are only guidelines and they do not mean that, if exceeded, anything drastic will happen. They argue that the level of risk that is acceptable is a matter of personal preference. The standards are there to serve as guides to individuals and decisionmakers.

The DOE standard states that risk should not be taken unless there is a benefit derived from the risk. If there is no benefit, then the risk should be reduced or eliminated, if possible.

The standards that are still in effect today and which were also in effect at the time the DOE completed its 1978 radiological study of Rongelap and other Marshall Island atolls is 500 millirem per year (0.5 rem) or 5 rem over 30 years (whole body dose). The 1982 DOE Bilingual Report concludes that the highest average amount of radiation people might receive in the coming 30 years (30 year dose) is 2500 millirem in any part of the body and 3300 millirem in just the bone marrow. Both of these values were within the DOE standard.

There are two issues related to standards that are unique to the Rongelap population.

First, the absence of individual dose assessments makes it impossible for individuals to determine the risk to themselves and their families. Some individuals in the population may not suffer much risk from resettling Rongelap in its present condition. However, several groups within the population cannot necessarily be guided by an assessment that is stated in **highest average** values. For example, about 70 members of the Rongelap population that experienced the Bravo fallout are still living. This group was subjected to a dose of 190 rem at the time of the blast and has been exposed to further radiation while living on Rongelap between 1957 through 1985. DOE says the most that this group can expect to receive on Rongelap over the next 30 years is about 3 rem and that, in view of the excessive dose they have already received, the risk would be relatively small. This is a difficult proposition to accept, since the question must be asked that when an individual has already received many times a currently acceptable lifetime dose of radiation, how can further exposure to even low levels of radiation be acceptable? Perhaps if individual dose assessments were developed and an upper range of anticipated radiation dose were available, then an informed decision about risk could be made by these people. However, at the present time, this information does not exist in a form they can use.

A second issue relates to infants and small children. The DOE standard is based on the risk of an adult male and does not necessarily pertain to women and children. Therefore, dose expressed in **highest average** values when compared to the standard does not provide these individuals or decisionmakers with useful information for making decisions about risk.

The adult female cancer risk from radiation is about 1.5 times that of the adult male, and for children, the risk is several times greater than for adults. Since decisions are pending as to whether to relocate these individuals to Rongelap Atoll, which has not yet be subjected to cleanup, more specific numerical values relating individual dose to appropriate standards for women and children are necessary to judge the acceptability of the risk involved in such a decision. If these risks are unacceptable, then cleanup will be necessary.

Generally, radiation standards are becoming more stringent. The DOE has proposed new DOE facility guidelines that would limit exposure to 0.1 rem per year or 3 rem over 30 years (whole body dose). However, these standards are not currently in effect.

Other agencies have established radiation standards that are more stringent than those employed by DOE. For example, the International Commission on Radiological Protection (ICRP) standard is 0.1 rem per year or 3 (whole body dose) rem over a 30 year period. Also, the Environmental Protection Agency (EPA) has recently proposed a new interim guidelines on doses to persons exposed to plutonium and transuranics. EPA concludes "that transuranic elements, especially plutonium, have been recognized as hazardous even in very small amounts," and establishes a radiation protection guide of 100 millirem from all sources, within which specific doses limits for transuranics to the lung and bone tissue are proposed.

The standard used for cleanup of plutonium at the Johnston Island military facility in the South Pacific was equivalent to the proposed EPA standard.

There, the Defense Nuclear Agency (DNA) employed a innovative plutonium mining technique to decontaminate the island to a standard of 100 millirem to protect the military population of the Island. Since children and women are involved in the Rongelap resettlement, the Johnston Island standard would be practical and desirable as the minimum acceptable cleanup standard for Rongelap Atoll.

The relationship between the results of radiological and health studies and the proposed level and extent of decontamination are directly related. The greater the level of risk to the population, the more stringent the level of clean-up required to assure habitable conditions on Rongelap Atoll for the resettlement of the population.

Decontamination can involve stripping away the top level of the soil profile, removing contaminated vegetation, or application of potassium salt, or both. The Rongelap Reassessment Report recommends that a plan be developed "to control contamination to the extent necessary to make the Rongelap people feel comfortable with their Atoll." The appropriate level of clean-up required depends upon agreement over the extent of risk involved in relocating the entire population. At the present time, such agreement does not exist. In order to resolve the question of the conditions of resettlement and the extent of cleanup required, we recommend that:

- 19. The most stringent radiation standards be employed in determining the acceptable level of risk for the Rongelap people to Rongelap Atoll, and that an appropriate risk assessment be done to guide decisionmaking regarding resettlement.**

Decontamination can involve stripping away the top level of the soil profile, removing contaminated vegetation, and application of potassium salt. Dr. Kohn recommends in the Rongelap Reassessment Report that a plan be developed "to control contamination to the extent necessary to make the Rongelap people feel comfortable with their Atoll":

Two methods developed at Bikini Atoll might be adapted for use here -- soil removal or soil treatment with potassium salt. The plan would be a graded one in which the northern islands would receive more treatment than Rongelap itself...

DOE officials believe that Rongelap Island does not necessarily require clean-up before resettlement; however they have suggested to the Rongelap people that they employ potassium salt soil treatment on the Island to offset concerns over cesium uptake in plants, the principal source of ingested radiation and largest contributor to DOE 30-year dose estimates. Potassium has been found to be preferred by plants over cesium. DOE experiments on Eneu Island in Bikini Atoll demonstrated a 90 percent reduction in cesium uptake soon after potassium was applied. Since coral soils found on most Marshall Islands atolls are at the margin for potassium deficiency any, this method serves the added purpose of enriching the soil while reducing cesium exposure.

DOE now prefers soil treatment cleanup to the scraping method, which heavily impacts island vegetation and requires years of recovery time before the effects of the decontamination on the environment reside. Enewetak was decontaminated by scraping the topsoil at a cost of approximately \$200 million and the lack of vegetation on the atoll today is a major negative impact of the project. Aesthetically the island is badly scarred, few trees protect the islanders from intense heat, and the prospects for agricultural and tourism economic development are now limited.

While potassium applications may have their place in the protection of the Rongelap people from contamination, other more effective, less expensive options have been successfully employed by the United States Government, and these options should be studied for use on Rongelap Atoll.

In a paper prepared by E. T. Bramlitt of the Defense Nuclear Agency, the relative standards for clean-up of sites in the Marshall Islands are compared with that of the clean-up of contaminated portions of the military installation at Johnston Island (see

Appendix G). Bramlitt's primary concern is plutonium clean-up and to report on a new less-costly mining method of decontamination developed for the DNA. Using the new mining technology, Johnston Island was decontaminated to levels well in excess of those achieved at Enewetak and the clean-up was less destructive to vegetation. Bramlitt also reports that the clean-up was accomplished at one-tenth the cost of other clean-up methods. He concludes:

The scope of the JA cleanup is comparable to Enewetak cleanup. However, based on pilot plant results, a "true soil cleanup" at JA is expected to cost less than 10 % of that at Enewetak.

Rongelap desires the most thorough cleanup possible at the least cost. It also expects that the cleanup standard employed on Rongelap Atoll will be no less than that achieved at Johnston Island.

We recommend:

- 20. The DNA (Bramlitt) plutonium mining cleanup method be tested on Rongelap Island as part of the Phase 2 study to determine whether it: 1) is an effective cleanup method; 2) will have less adverse impact on vegetation; and 3) will result in reduced decontamination costs.**

ECONOMIC IMPACTS

The economic impacts of radiological contamination of Rongelap Atoll are perhaps the least understood and discussed of the various impact issues. DOE refers to the need to study the problem in its 1980 Marshall Islands Radiological Work Plan:

The only cash crop for the northern Marshall Island atolls is copra. Cesium -137 and Strontium -90 are absorbed through the root system of the coconut trees and incorporated into the coconut meat which can be used directly or dried. Consequently, it is essential to know how the radionuclides are distributed in the products resulting from processing of the copra....

The importance of copra on the economy of the Marshall Islands, and on the economy of Enewetak and Bikini Atolls in particular, is of such importance that the experiments to determine the radionuclide distribution in copra products from the different methods should be carried out. **Only limited studies have been possible in current programs.**

No studies have been done on what the daily economic life will be like on Rongelap Atoll once restoration and resettlement is accomplished. The extent to which the Rongelap people will have a viable economy to support "habitability" is uncertain at best. Political decisionmakers need solid economic analyses to ascertain the extent to which the Rongelap people will be dependent upon outside support for their livelihood and for how long. They need sound ideas and strategies to allow for Rongelap to become a productive member of the Marshall Islands community.

The Bravo blast profoundly affected the basic economy of the Atoll and disrupted the livelihood of the Rongelap people. Dependence upon food shipments and relief has become a fact of every day life on Majato, and may well become a fact of life on Rongelap after resettlement. The traditional economic activity of copra sales and the ability to gather food from throughout the Atoll have ceased as traditional economic

activities. It may be difficult to reinstate these activities even with adequate clean-up and restoration of the islands. Also, prospects for the local consumption of shellfish is remote without cleanup, and the ability to restore any sort of reasonable economic activity related to the fishing industry is unknown. However, we can presume that buyers of fish or shellfish from the Rongelap waters will be wary, if not totally reluctant, until the area has a clean radiological bill of health.

Clearly, the nature of the future economy of the Northern Marshall Islands is uncertain, at best, and is a problem that must be addressed if resettlement of Rongelap or any other Atoll populations is to be successful. The Republic of the Marshall Islands is a new country with a desire for a stronger, more independent economy for its people. The future economies of Bikini, Enewetak, Rongelap and Utirik and other Atolls affected by the U.S. weapons testing program will require careful planning and considerable creativity if these areas are to ultimately become viable and productive areas of the nation's economy.

Some tourism and economic development is not out of the question for Rongelap Atoll, assuming decontamination is accomplished at levels to reduce Rongelap's contamination history as a tourism deterrent. If restoration can be accomplished so that damage to vegetation and other aspects of the natural environment and the scenic attributes of the Atoll can be preserved, then accommodations for limited tourist facilities may be possible if coupled with a creative marketing approach. Even if decontamination should adversely affect the scenic beauty of the Atoll, revegetation technology used by developers in the United States can be transferred and used on the Atoll.

Agricultural development is also a very real prospect. The Holmes and Narver Rehabilitation and Resettlement Study, which provides a blueprint for restoration and resettlement of the Atoll, the study presumes that a clean-up will occur which will restore much of the traditional food gathering activities. Agriculture is expected to be a major element of the economy:

After the Rongelapese return to their Atoll, some of their subsistence will come from foods grown in small garden plots near their homes. Additionally, larger areas of ground will need clearing for the planting of crops like breadfruit and pandanus....

While Holmes and Narver concedes that the means for rehabilitating each Atoll island is undefined, they anticipate that a fertilizer treatment program may enhance the restoration of the Atoll's agricultural capability.

Therefore, it is of the utmost importance that the soil used for agricultural purposes be as contamination-free as possible to provide safe produce--be it for local consumption or export. And the preservation of topsoil is a critical concern, since without it, agricultural activity, and for that matter, and habitable conditions in general, will be limited.

The eventual development of a productive economic activity for the Rongelap people is a major concern of the Rongelap Council. Habitability of the atoll is dependent upon a clear understanding of what economic endeavors will be available to the Rongelap people when they return. The success of rehabilitation and restoration and new economic opportunities are needed to restore Rongelap atoll as a productive part of the Marshall Islands' economy. Ultimately the success of any decontamination effort must not only be convincing to the Rongelap people, but it must be convincing to the general public as well. If it is not, resettlement will fall far short of habitable circumstances the Rongelap people feel they have a right to expect from the Compact for Free Association. Therefore, we recommend:

21. A study of the environmental and economic impacts of radiological contamination be performed as an element of the Phase 2 Study. This study should address the overall life on Rongelap in a meaningful, comprehensive fashion which considers all aspects of the human and natural environment.
22. An analysis of the various economic opportunities and constraints associated with various decontamination and rehabilitation scenarios.
23. A realistic economic development strategy/plan for Rongelap, Ailinginae, and Rongerik Atolls that minimizes dependence on imported food and maximizes the opportunities for the Rongelap people to be economically self-sufficient.
24. An assessment of the importance of vegetation preservation to economic activities on the Atoll with specific attention to:
1) the potential for utilizing revegetation technology employed in the development industry in the United States and its potential for technology transfer to the Marshall Islands; 2) feasibility and costs replanting mature plants after cleanup, and 3) determination of agricultural benefits of potassium soil treatments for cesium 137 control.

SOCIOLOGICAL AND PSYCHOLOGICAL IMPACTS

Any dislocated population is subject to numerous community and family stresses. Added stress over concern for the health of the general population and particularly for the health of their children require an understanding and appreciation of cultural and religious factors. The Rongelap people tend to have large families and due to the limited size of the community, intermarriage with close relatives sometimes occurs. The various habits and lifestyle factors of island life are important to accurate dose and risk assessment. This is particularly crucial in determining diet and radiological impacts on infants and small children. Finally, the expectations and desires of different age groups within the population regarding resettlement requires the attention of a Phase 2 study if a successful resettlement effort is to become reality.

For these reasons, a sociologist should be intricately involved in the study and should assist in guiding research and data collection and participate in identifying various sociological factors pertinent to risk assessment and relocation.

The psychological effects of repeated and continued exposure are a concern of the Rongelap people that has not been addressed by previous studies. A psychologist or psychiatrist may be required on the study team to better understand these effects.

We therefore recommend:

25. The Phase 2 study team include a qualified sociologist, and psychologist as readily available consultants having experience and knowledge of Marshall Islands peoples and cultures. These specialists will provide assistance in guiding data collection and analyses and assure required sensitivity to cultural needs of the Rongelap people. They will also assist in understanding the psychological effects of radiation exposure.

V. STUDY IMPLICATIONS

The Phase 2 Work Plan proposed in this report will resolve outstanding radiological, health and environmental issues relative to the future habitability of Rongelap Atoll. First, it establishes a process for resolving the longstanding issues regarding the habitability of Rongelap Atoll and for implementing the requirements of the Compact of Free Association. The creation of a **Rongelap Radiological and Health Study Management Committee** is recommended. It would be given the authority to oversee the operation and success of the Phase 2 study. A distinguished group of individuals having a broad spectrum of viewpoints and depth of experience would be appointed to serve in this capacity. It is important that these individuals have the necessary credibility and objectivity to assure the interest of all parties -- Rongelap, the Republic of the Marshall Islands, the U.S. Department of Energy and the U.S. Government -- are dealt with fairly and properly.

Second, the plan proposes the full use of existing DOE radiological and health data collected over the years on the Rongelap people and Rongelap Atoll (to the extent such data is made available), and provides for its review by independent consultants, staff and the Management Committee. We believe this will eliminate much of the uncertainty that has developed since the DOE Bilingual Report was issued in 1982. The DOE data base will be buttressed, as necessary, with new data and information, and will be reanalyzed in the context of the new data. Appropriately stringent standards and criteria, as determined by the Management Committee, will be employed to determine risk.

Third, outstanding issues relating to disputes over various scientific approaches being employed in determining dose will be decided by the Management Committee after thorough review and analysis. We believe this will eliminate uncertainty over which approaches are adequate to assure the health and safety of the Rongelap people upon resettlement, or whether new approaches are desirable.

Fourth, the study will develop complete medical profiles and records on each member of the Rongelap population, so that every Rongelap individual will be able to judge their risk when resettlement comes. This survey will be useful in determining the general health of the Rongelap population and the kinds of health problems they can expect in the coming years, whether resettlement occurs or not.

Fifth, the Work Plan includes an independent plutonium and transuranic dose assessment with particular emphasis on the impacts of these radiological elements on infants and children.

Sixth, the study will examine fully the economic, environmental, and social impacts of radiation on Rongelap Atoll and the Rongelap people and will recommend solutions to achieve habitable standards upon resettlement.

Seventh, various options for cleanup of Rongelap Atoll will be examined. We also propose that the plutonium mining technology employed by the U.S. Defense Nuclear Agency in the cleanup of Johnston Island be tested on Rongelap Atoll to determine if it will be useful in reducing environmental impacts and costs of cleanup.

Finally, we believe this study will form a new basis for improved understanding and communication between Department of Energy officials administering Marshall Island's programs and the Rongelap people. In the context of a truly independent, comprehensive study, the DOE data and information can be utilized and verified to the satisfaction of the Rongelap people and will become the basis for credible decisions regarding resettlement and decontamination of Rongelap Atoll.

VI. SUMMARY OF RECOMMENDATIONS

- 1. A complete physical and health assessment of each man, woman and child be conducted during the early stages of the Phase 2 study by an independent team of physicians and specialists. This health assessment should include, among other things, the taking of blood samples to develop additional chromosome and cytogenetic data on each individual. This team should be available at Ebeye and Majato (and, if necessary Majuro) for a length of time necessary to fully examine all of the members of the Rongelap community.**
- 2. Blood chromosome, physical examination data, and surgical data accumulated by Brookhaven National Laboratories be released to the independent health contractor as necessary for examination, computerization and analysis.**
- 3. Additional soil water and marine samples be collected on Rngelap Atoll as necessary to augment and complement the existing DOE data base. In doing so, sufficient collection of samples should occur on all islands around the lagoon to develop parameters for cleanup and resettlement.**
- 4. A whole body counter be established in a permanent location in the Marshall Islands accessible to the study team and to the general Rongelap population to facilitate data collection and to minimize travel difficulties.**
- 5. Individual dosage data be correlated as closely as possible with information obtained in baseline health surveys to determine the health risk associated with resettlement of each individual.**
- 6. Dose assessments using both the mixed food and local food diet models will be developed utilizing, where appropriate, DOE data.**
- 7. A determination of the current diet of the Rongelap people and realistic diet options keyed to various levels of clean-up at Rongelap Island, Rongerik and Ailinginae be developed. If dependence upon imported food to be brought by ship is to support a major element of the diet, then the history of the frequency and reliability of these supplies should be taken into account, and appropriate adjustments made. This aspect of the study should be done by qualified dieticians who can ascertain the diet needs and expectations for the entire population, infants, children and adults, and people with health-restricted diets.**
- 8. Determine the length of time the Rongelap population will be expected to depend heavily upon imported food for their diet should resettlement and clean-up occur.**
- 9. The diet models should be subjected to appropriate sensitivity analyses.**

10. **Develop a plutonium and transuranic research program for Rongelap that will:**
 - o **Take multiple urine samples of all previous residents of Rongelap Atoll.**
 - o **Perform analysis under stringent and independent quality control.**
 - o **Determine distribution of transuranics in soil at Rongelap Atoll.**
 - o **Determine micro-distribution and particle sizes of transuranics in soil.**
 - o **Evaluate the effect of behavior of infants and children on increased plutonium dose (crawling on the ground, ingestion of soil etc.).**
 - o **Determine concentration of transuranics in prepared food.**
 - o **Evaluate potential uptake of transuranics through wounds and skin.**
 - o **Examine the uncertainty of dose estimation process, and develop an acceptable assessment methodology.**
11. **The Management Committee review excretion functions available for determining plutonium body burden based on levels found in urine. An excretion function that would be reasonably conservative for the Rongelap people should be employed.**
12. **The DOE be requested to provide all sampling and analysis information and assistance to the study team for its review and assist as necessary to determine the accuracy of the Phase 2 plutonium analysis.**
13. **The Phase 2 study team enter into an agreement with the DOE and Brookhaven National Laboratory to employ its fission tracking system in conducting analysis of urine samples for plutonium, and that appropriate procedures be established to protect the independent nature of the study.**
14. **Analyze the existing DOE data on dose for each individual planning to resettle Rongelap Atoll and initiate a renewed testing program to effect accurate individual dose assessments.**
15. **Individual dose assessments should fully account for all previous radiation exposure experienced by members of the Rongelap population including the initial exposure from the Bravo blast. Dosage should cover periods of time that more realistically relate to the Rongelap experience, such as 1954-1984.**

16. The recommendation contained in the Rongelap Reassessment Report to "extend the study of infant diets and those of small children" be implemented.
17. A "worst case" scenario be used to determine the risk for infants and small children and that the assumptions used in any radiological assessment model for children be subjected to thorough sensitivity analyses. Every effort should be made to eliminate the prospect for any child being subjected to radiation unnecessarily and should assume that Rongelap children, like other children around the world, will be able to move freely and manipulate and interact with their environment.
18. An appropriate excretion formula be developed to analyze plutonium in children.
19. The most stringent radiation standards be employed in determining the acceptable level of risk for the Rongelap people to Rongelap Atoll, and that an appropriate risk assessment be done to guide decisionmaking regarding resettlement.
20. The DNA (Bramlitt) plutonium mining cleanup method be tested on Rongelap Island as part of the Phase 2 study to determine whether it: 1) is an effective cleanup method; 2) will have less adverse impact on vegetation; and 3) will result in reduced decontamination costs.
21. A study of the environmental and economic impacts of radiological contamination be performed as an element of the Phase 2 Study. This study should address the overall life on Rongelap in a meaningful, comprehensive fashion which considers all aspects of the human and natural environment.
22. An analysis of the various economic opportunities and constraints associated with various decontamination and rehabilitation scenarios.
23. A realistic economic development strategy/plan for Rongelap, Ailinginae, and Rongerik Atolls that minimizes dependence on imported food and maximizes the opportunities for the Rongelap people to be economically self-sufficient.
24. An assessment of the importance of vegetation preservation to economic activities on the Atoll with specific attention to: 1) the potential for utilizing revegetation technology employed in the development industry in the United States and its potential for technology transfer to the Marshall Islands; 2) feasibility and costs replanting mature plants after cleanup, and 3) determination of agricultural benefits of potassium soil treatments for cesium 137 control.

25. The Phase 2 study team include a qualified sociologist, and psychologist as readily available consultants having experience and knowledge of Marshall Islands peoples and cultures. These specialists will provide assistance in guiding data collection and analyses and assure required sensitivity to cultural needs of the Rongelap people. They will also assist in understanding the psychological effects of radiation exposure.

**VII. BUDGET ESTIMATES
PHASE 2 COMPREHENSIVE STUDY**

Administrative Costs	
Staff/Committee/Office	1,100,000
Related costs	450,000
Radiological survey (includes logistical support)	1,600,000
Bioassay, diet survey	700,000
Dose assessment	400,000
Baseline health survey (includes logistical support)	1,020,000
Socio/economic/environmental study	300,000
Test plutonium mining cleanup technology	490,000
Contingencies (10%)	560,000
 TOTAL	 \$6,620,000

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COMPACT OF FREE ASSOCIATION ACT OF 1985

PUBLIC LAW 99-239—JAN. 14, 1986

99 STAT. 1783

department or agency of the United States or by contract with a United States firm) shall continue to provide special medical care and logistical support thereto for the remaining 174 members of the population of Rongelap and Utrik who were exposed to radiation resulting from the 1954 United States thermonuclear "Bravo" test, pursuant to Public Laws 95-134 and 96-205. Such medical care and its accompanying logistical support shall total \$22,500,000 over the first 11 years of the Compact.

91 Stat. 1159.

94 Stat. 84.

(2) **AGRICULTURAL AND FOOD PROGRAMS.**—Notwithstanding any other provision of law, upon the request of the Government of the Marshall Islands, for the first five years after the effective date of the Compact, the President (either through an appropriate department or agency of the United States or by contract with a United States firm) shall provide technical and other assistance—

President of U.S.

(A) without reimbursement, to continue the planting and agricultural maintenance program on Enewetak;

(B) without reimbursement, to continue the food programs of the Bikini and Enewetak people described in section 1(d) of Article II of the Subsidiary Agreement for the Implementation of Section 177 of the Compact and for continued waterborne transportation of agricultural products to Enewetak including operations and maintenance of the vessel used for such purposes.

Post, p. 1812.

(3) **PAYMENTS.**—Payments under this subsection shall be provided to such extent or in such amounts as are necessary for services and other assistance provided pursuant to this subsection. It is the sense of Congress that after the periods of time specified in paragraphs (1) and (2) of this subsection, consideration will be given to such additional funding for these programs as may be necessary.

(i) **RONGELAP.**—(1) Because Rongelap was directly affected by fallout from a 1954 United States thermonuclear test and because the Rongelap people remain unconvinced that it is safe to continue to live on Rongelap Island, it is the intent of Congress to take such steps (if any) as may be necessary to overcome the effects of such fallout on the habitability of Rongelap Island, and to restore Rongelap Island, if necessary, so that it can be safely inhabited. Accordingly, it is the expectation of the Congress that the Government of the Marshall Islands shall use such portion of the funds specified in Article II, section 1(e) of the subsidiary agreement for the implementation of section 177 of the Compact as are necessary for the purpose of contracting with a qualified scientist or group of scientists to review the data collected by the Department of Energy relating to radiation levels and other conditions on Rongelap Island resulting from the thermonuclear test. It is the expectation of the Congress that the Government of the Marshall Islands, after consultation with the people of Rongelap, shall select the party to review such data, and shall contract for such review and for submission of a report to the President of the United States and the Congress as to the results thereof.

Hazardous materials.
Contracts.

Post, p. 1812.

Report.

(2) The purpose of the review referred to in paragraph (1) of this subsection shall be to establish whether the data cited in support of the conclusions as to the habitability of Rongelap Island, as set forth in the Department of Energy report entitled: "The Meaning of Radiation for Those Atolls in the Northern Part of the Marshall Islands That Were Surveyed in 1978", dated November 1982, are

Report.

adequate and whether such conclusions are fully supported by the data. If the party reviewing the data concludes that such conclusions as to habitability are fully supported by adequate data, the report to the President of the United States and the Congress shall so state. If the party reviewing the data concludes that the data are inadequate to support such conclusions as to habitability or that such conclusions as to habitability are not fully supported by the data, the Government of the Marshall Islands shall contract with an appropriate scientist or group of scientists to undertake a complete survey of radiation and other effects of the nuclear testing program relating to the habitability of Rongelap Island. Such sums as are necessary for such survey and report concerning the results thereof and as to steps needed to restore the habitability of Rongelap Island are authorized to be made available to the Government of the Marshall Islands.

(3) It is the intent of Congress that such steps (if any) as are necessary to restore the habitability of Rongelap Island and return the Rongelap people to their homeland will be taken by the United States in consultation with the Government of the Marshall Islands and, in accordance with its authority under the Constitution of the Marshall Islands, the Rongelap local government council.

Hazardous
materials.

Ante, p. 1781.

91 Stat. 1159.
94 Stat. 84.

(j) **FOUR ATOLL HEALTH CARE PROGRAM.**—(1) Services provided by the United States Public Health Service or any other United States agency pursuant to section 1(a) of Article II of the Agreement for the Implementation of Section 177 of the Compact (hereafter in this subsection referred to as the "Section 177 Agreement") shall be only for services to the people of the Atolls of Bikini, Enewetak, Rongelap, and Utrik who were affected by the consequences of the United States nuclear testing program, pursuant to the program described in Public Law 95-134 and Public Law 96-205 and their descendants (and any other persons identified as having been so affected if such identification occurs in the manner described in such public laws). Nothing in this subsection shall be construed as prejudicial to the views or policies of the Government of the Marshall Islands as to the persons affected by the consequences of the United States nuclear testing program.

(2) At the end of the first year after the effective date of the Compact and at the end of each year thereafter, the providing agency or agencies shall return to the Government of the Marshall Islands any unexpended funds to be returned to the Fund Manager (as described in Article I of the Section 177 Agreement) to be covered into the Fund to be available for future use.

(3) The Fund Manager shall retain the funds returned by the Government of the Marshall Islands pursuant to paragraph (2) of this subsection, shall invest and manage such funds, and at the end of 15 years after the effective date of the Compact, shall make from the total amount so retained and the proceeds thereof annual disbursements sufficient to continue to make payments for the provision of health services as specified in paragraph (1) of this subsection to such extent as may be provided in contracts between the Government of the Marshall Islands and appropriate United States providers of such health services.

Hazardous
materials.

Post, p. 1812.

(k) **ENJERI COMMUNITY TRUST FUND.**—Notwithstanding any other provision of law, the Secretary of the Treasury shall establish on the books of the Treasury of the United States a fund having the status specified in Article V of the subsidiary agreement for the implementation of Section 177 of the Compact, to be known as the

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EDUCATION

Bachelor of Arts in History. January, 1968. **University of Arkansas, Fayetteville.**

Masters of Arts in Political Science. June, 1974. **Arizona State University, Tempe.**

EXPERIENCE

1988-1989. **Associate Vice President & Director of Technical Studies, P&D Technologies, Phoenix, AZ.** Consultant in strategic planning/asset management of large real estate holdings. Specialist in land exchanges with Federal agencies e.g. Forest Service, BLM. Coordinate selected energy environmental/public policy studies.

1987-1988. **Vice President, Phelps Dodge Development Co., Tucson/Phoenix, AZ.** Managed governmental relations and implemented corporate strategy for exchange of 15,000 acres of private, scenic, recreational/environmental properties for asset enhancement.

1982-1987. **Arizona State Land Commissioner, Phoenix, AZ.** Responsible for managing and developing policy for Arizona State Land Department. As a cabinet level state official, I supervised 150 multi-disciplined professionals, administered 13,000 leases covering 9.5 million acres and revenues in excess of \$60 million annually. Implement innovative Urban Lands Act employing private-sector concepts to increase value for state lands and initiated major Federal/State land exchange program to trade pristine scenic/habitat/wilderness lands for developable revenue/producing properties. Renovated and modernized commercial leasing and agricultural leasing and water resource programs. Also, member of Arizona State Parks Board, Az. State Conservation Commissioner, State Forester, and member of Az. Transmission Line Siting Commission.

1979-1982. **Deputy State Land Commissioner.** Assisted the State Land Commissioner in administering the Department (duties described above).

1977-1979. **Special Assistant to the Asst. Secretary of the Interior for Land and Water Resources, Department of the Interior, Washington, D.C.** Water project specialist. Supervised study/replanning of Garrison Diversion Unit, N.D., and Oahe Unit, S.D. (including supervision of a major environmental impact statement) and directed major congressionally-authorized study of the Central Valley Project, California.

1975-1977. **Assistant for Environment, Subcommittee on Conservation, Energy and Natural Resources, House Government Operations Committee, U.S. Congress, Washington, D.C.** working with GAO, investigated broad range of Federal natural resource and energy programs for efficiency and effectiveness.

1974-1975. **Staff assistant, National Oceans Policy Study.** Senate Commerce Committee, U. S. Congress, Washington, D.C.

1972-74. **Specialist in Environmental Policy, Congressional Research Service, Library of Congress, Washington, D.C.**

1969-1970. **Press Liaison, Senate Sergeant-at-Arms Office, U.S. Senate, Washington, D.C.**

1970. **Staff, Office of Senator John L. McCellan, U.S. Senate, Washington, D.C.**

1965. **Student Intern, Office of Congressman Oren Harris, U.S. House of Representatives, Washington, D.C.**

MILITARY SERVICE

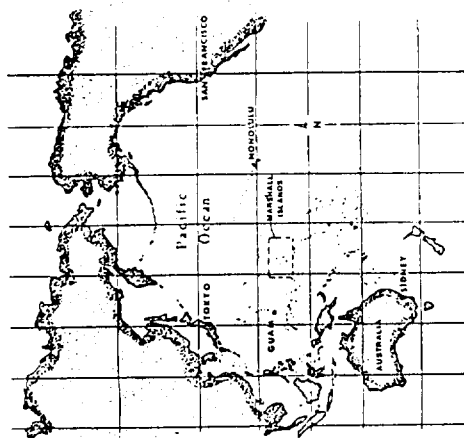
1967-1969. **U.S. Naval Reserve. (Lieutenant. Officer Candidate School, Newport, R.I. Naval Damage Control and Nuclear, Biological. Chemical Warfare Defense School, Philadelphia, PA. Served aboard USS America (CVA-66), Vietnam Veteran.**

**ORGANIZATION/
HONORS**

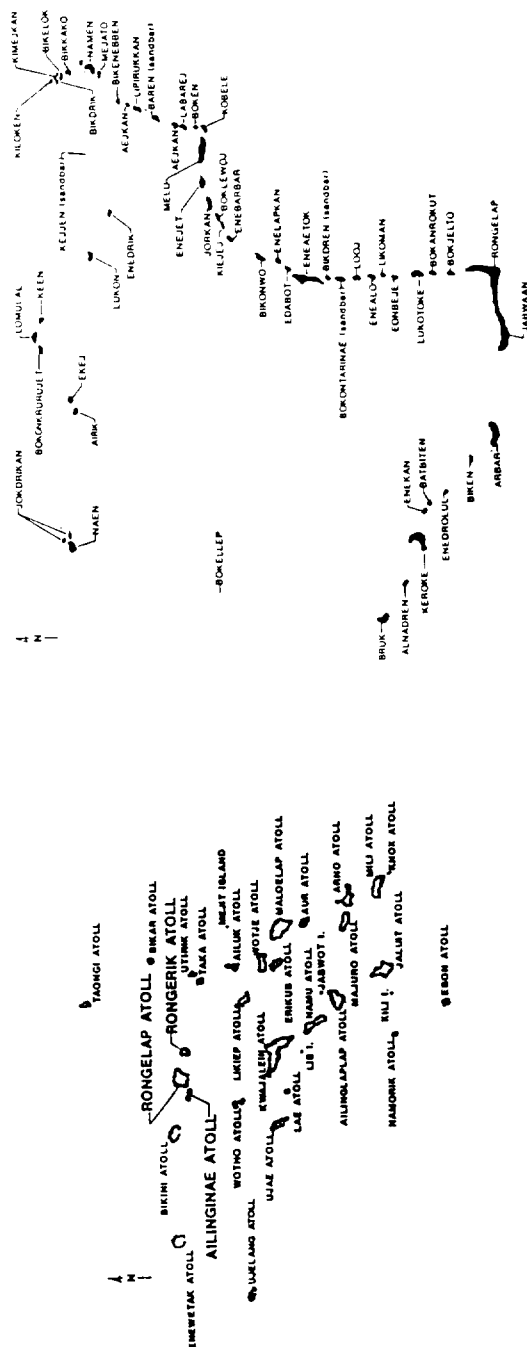
Board of Trustees, Arizona Nature Conservancy
Heard Museum Men's Council
Member Emeritus and Former Vice President, Western State Land Commissioner's Association
Citation of Merit, December 22, 1986, Governor Bruce Babbitt, Arizona
Former member, Governor's Desert Task Force
Former member, Governor's Task Force of Recreation on Public Lands
Former member, Scottsdale, Desert Lands Protection Committee
Member, All Saints Episcopal Church, Phoenix, Arizona

**MARITAL STATUS/
INTERESTS**

Single, one child Ethan (10). Hiking, jogging, tennis, oil painting, and writing.



REGIONAL MAP-PACIFIC AREA



REPUBLIC OF THE MARSHALL ISLANDS

RONGELAP ATOLL

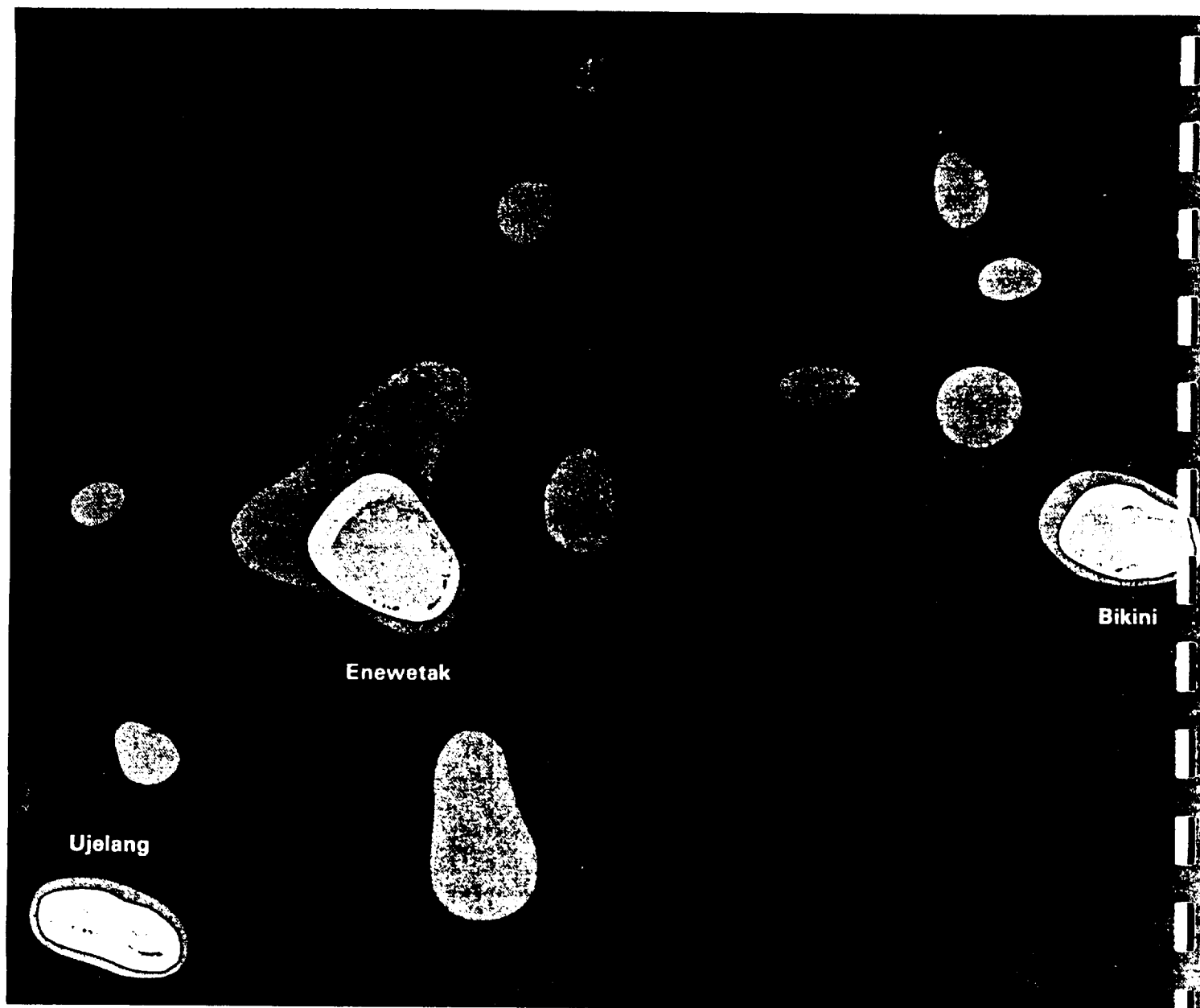


TITLE.
VICINITY MAPS

PREPARED BY:
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APPENDIX D

Map excerpted from "The Meaning of Radiation in the Northern Part of the Marshall Islands that were surveyed in 1978", Department of Energy, November, 1982, pp.8-9.



Map in ej kwalok ene ko ilo ailiñ ko ituion ilo
 Majol im Kien eo an United States ear etali ilo
 1978. Jet ian ene kein elaplok jonan atom ko
 reradioactive ie jen ene ko jet. Unin, kink e p...
 ene ko ilo ailiñ in Bikini im ailiñ in Enewetak...
 ijo rar kôkômmâlmel bomb ko ie. Bareniwai Ene...
 ar bookilok atom ko reradioactive im tibdrikerikiri
 bomb ko ñôn ene ko ilo ailiñ ko jet ituion ilo
 Majol



This map shows the islands in the northern part of the Marshall Islands that the U.S. government surveyed in 1978. Some of these islands have more radioactive atoms on them than others. The reason is because some of the islands at Bikini Atoll and Eniwetok Atoll are where they tested the bombs. Also the wind blew radioactive atoms and tiny particles of the bombs to islands in other atolls in the northern part of the Marshall Islands.

1	2	3	4
Edrik tok johan atom ko re radioactive	Edrik tok johan atom ko re radioactive	Edrik tok johan atom ko re radioactive	Edrik tok johan atom ko re radioactive
The least amount of radioactive atoms	A small amount of radioactive atoms	A larger amount of radioactive atoms	The largest amount of radioactive atoms

TABLE N- 8 #1 DAILY FOOD CONSUMPTION -- TWO DIETS ^{a/}

Food	Community B (adult) grams/day	MLSC Diet (adult female) grams/day
Arrowroot	0	3.9
Breadfruit	36	27.2
Banana	19	0.02
Coconut		--
Drinking meat	100	--
Drinking fluid	514	--
Copra	68	--
Milk	125	--
Sprouting	100	--
Coconut "fluid"	--	142
Coconut "meat"	--	63.3
Papaya	0	6.6
Pumpkin	0	1.2
Pandanus	96	9.2
Fish	194	41.5
Eggs	--	10.7
Poultry	3	--
Wild birds	9	4.2
Domestic meat	--	21.2
Pork	1.4	--
Clams	15	8.9
Crabs	--	3.1
Octopus	20	4.5
Turtle	.1	4.3
Snails	12	--
Coconut crab	1	--
Lobster	.14	--
Shellfish	--	5.1
Total	1313.64	356.92

^{a/} Imported foods are not included in the lists. The data are from Tables 4 and 11 in Robison et al, UCRL 52853 (1982b). Imported staples include rice (especially), sugar, flour, canned meat, canned drinks, and baby foods.

● Poster Presentations

PLUTONIUM MINING FOR CLEANUP

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Abstract—Cleanup is the act of making a contaminated site relatively free of Pu so it may be used without radiological safety restrictions. Contaminated ground is the focus of major cleanups. Cleanup traditionally involves determining Pu content of soil, digging up soil in which radioactivity exceeds guidelines, and relocating excised soil to a waste-disposal site. Alternative technologies have been tested at Johnston Atoll (JA), where there is as much as 100,000 m³ of Pu-contaminated soil. A mining pilot plant operated for the first 6 mo of 1986 and made 98% of soil tested "clean," from more than 40 kBq kg⁻¹ (1000 pCi g⁻¹) to less than about 500 Bq kg⁻¹ (15 pCi g⁻¹) by concentrating Pu in 2% of the soil. The pilot plant is now installed at the U.S. Department of Energy Nevada Test Site for evaluating cleanup of other contaminated soils and refining cleanup effectiveness. A full-scale cleanup plant has been programmed for JA in 1988.

In this paper, previous cleanups are reviewed, and the mining endeavor at JA is detailed. "True soil cleanup" is contrasted with the classical "soil relocation cleanup."

The mining technology used for Pu cleanup has been in use for more than a century. Mining for cleanup, however, is unique. It is envisioned as being prominent for radiological and other cleanups in the future.

INTRODUCTION

SEVERAL sites throughout the world have been contaminated with Pu as a result of nuclear weapons tests and accidents. The U.S. Environmental Protection Agency (EPA) has proposed very stringent criteria for the use of Pu-contaminated sites (EPA 1977; 1986). The International Atomic Energy Agency (IAEA) ranks Pu as the most radiotoxic element (IAEA 1962). The public sees Pu as dangerous. Plutonium-contaminated sites exist; accidents happen. The future will require Pu cleanups.

"Cleanup" is the act of making a contaminated site relatively free of Pu so that it may be used without radiological safety restrictions. Contaminated ground is the focus of major Pu cleanups. Cleanup traditionally involves determining Pu content of soil, digging up soil when Pu concentrations exceed guidelines, and relocating all soil removed to a waste disposal site. A "relocation cleanup" decontaminates the site; it does not decontaminate soil.

DISCUSSION

The volumes of soil involved in major Pu cleanups are shown in rank order in Fig. 1. The Palomares, Spain, and Thule, Greenland, cleanups in the mid-1960s relocated soil, snow and ice to South Carolina (Langham 1970; Otten 1970; Place et al. 1975). A Pu cleanup at the Rocky Flats Plant, CO, in 1975 relocated soil to Nevada.* The largest cleanup to date, Enewetak Atoll in 1977-1980,

relocated soil from five islands to a single island (Defense Nuclear Agency 1981). A comparable amount of Pu-contaminated soil is available for cleanup at a site on Johnston Atoll (JA). The site is restricted from use pending a suitable means for cleanup.

The quantity of soil involved in a cleanup is not solely a function of the amount of Pu released and the area contaminated. Controlling factors include the location of the contaminating incident, time between incident and cleanup, planned use for the site, cleanup procedures and equipment, and cleanup guidelines.

Cleanup is accomplished to avoid radiation dose. Cleanup guidelines specify doses which should not be exceeded. Doses considered have ranged from the maximum permissible for an individual member of the public (Healy 1974) to less than 1% of the "public limit" (EPA 1977; 1986).

Using dose as a guideline for operational Pu cleanup purposes is unsuitable because it is not directly measurable. Operational cleanup guides are expressed in units related to dose, such as Pu quantity (activity or weight) per unit area of ground or unit mass of soil. Figure 2 shows the ranked guides used at major Pu cleanups in equivalent units. The guides span more than three orders of magnitude.

A trend toward more stringent guidelines suggests that cleanups in the future will deal with even greater volumes of soil than those in the past. Volume-reduction alternatives appear essential to make cleanup manageable as well as to conserve limited radioactive waste disposal space.

* Personal communication (1986) with C. T. Isley, U.S. Department of Energy, Rocky Flats, CO 80401.

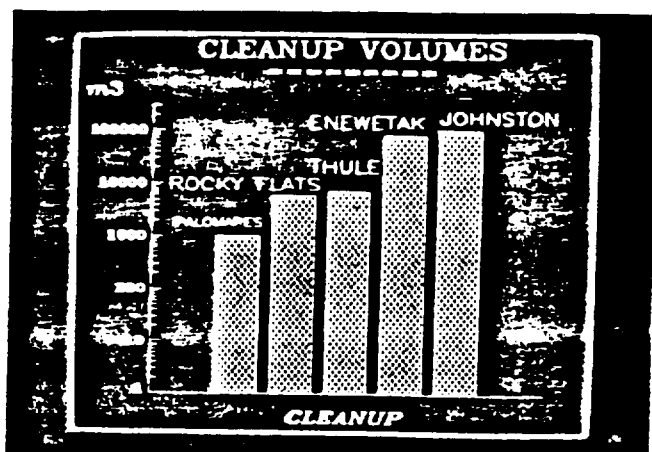


Fig. 1. Cleanup volumes.

Decontamination is a normal procedure for volume reduction. Items are washed, scrubbed, sandblasted, steam-cleaned, scabbled, etc., to make them clean and to minimize the material that must be relocated to a waste-disposal facility. Decontamination is expected for items which are intrinsically valuable or large and when it is simple and effective. Although decontamination has not been favored for soil cleanup, it has been accomplished on Pu-contaminated soil at JA.

The atoll was used in 1962 to launch nuclear devices to high altitudes to study nuclear effects. One missile failed on the launch pad, and two failed shortly after lift-off. In each instance, the devices were destroyed, and Pu was dispersed.

The incidents were followed by hasty cleanups which tentatively fixed contamination by paint, concrete, or "clean" soil and left much of the atoll under radiological controls. A more thorough cleanup was begun in 1983, when increased mission requirements demanded more effective use of the atoll. So far, all contaminated structures have been eliminated, and contaminated soil has been

consolidated (by relocation) in a single radiological control area.

For years, small amounts of JA soil have been manually decontaminated: A "hot spot" is dug up and divided. Iterative identification and division of the "hot" half leads eventually to a single "hot" particle. The particle may be Pu oxide too small to be seen, or a contaminated grain of sand or fragment of missile debris. Soil without the particle is decontaminated.

Some JA soil has also been naturally decontaminated. This is indicated by the presence of Pu behind weirs installed in ditches to retard soil erosion. The Pu accumulations are similar to gold placers found in stream beds. Soil which deposits its Pu in placers is decontaminated.

In 1984, Rocky Flats Plant personnel conducted laboratory tests to determine if common mining methods might be suitable for automatic decontamination of JA soil (Kochen and Blakeslee 1986). Tests evaluated froth flotation, ferrite treatment, attrition-scrubbing, ultrasonic treatment and dry-sieving, and concluded that dry-sieving might reduce the volume of contaminated soil by 50%, and that froth flotation could reduce the remaining contaminated soil by an additional 35%. In 1985, proposals were sought for a pilot plant and demonstration mining of Pu for cleanup. The successful proposal by the AWC Corporation (of Las Vegas, NV) was based on selective hindered settling. The AWC Corporation installed the plant at JA in late 1985 and operated it until June 1986.

Figure 3 shows major features of the pilot plant. The plant receives soil which has been assayed for Pu. Soil is sifted of small particles and crushed. The sized fractions are then combined and conveyed to a mineral jig, the heart of the plant. Water moves soil through the jig where heavier Pu particles are separated from lighter soil particles as panning separates gold from sand. Plutonium with a small amount of soil settles at the jig bottom, while soil with a small amount of Pu sluices over the jig top. The "clean" soil is dewatered, conveyed beneath an array of detectors, and discharged from the plant when Pu content is within limits. Water is recycled to the jig.

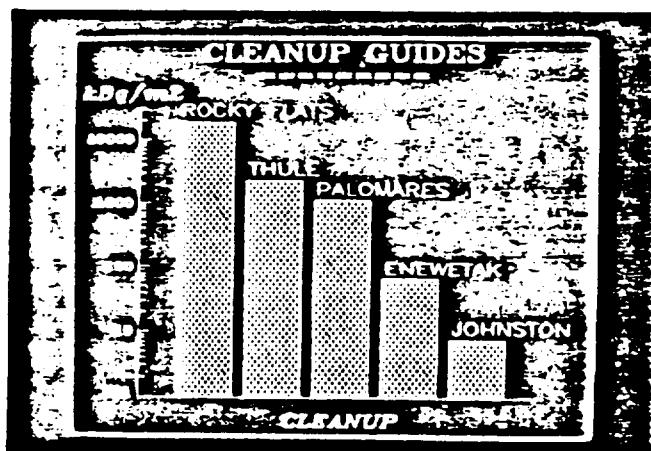


Fig. 2. Cleanup guides.

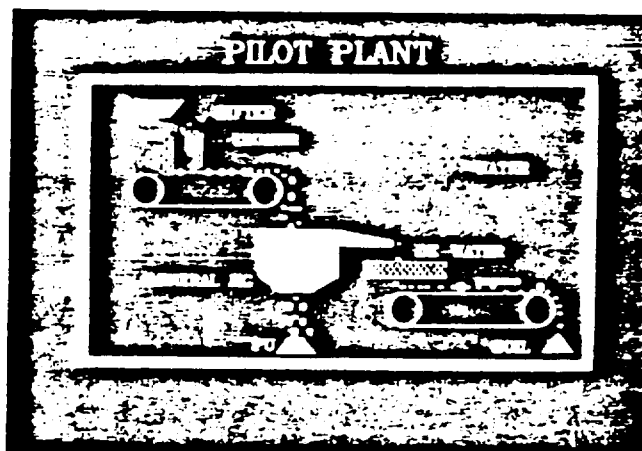


Fig. 3. Plutonium mining pilot plant.

The mineral jig is a simple device used for over 100 y to mine a variety of minerals. It may be visualized as a V-shaped tank of water with a bed of small metal balls resting on a screen toward the top of one arm. A stream of water moves soil over the bed. A synchronized diaphragm pump and water valve in the other arm pulse the bed from beneath. On the downward pump stroke, the valve closes to cause tank water to "open" the bed and push lighter particles higher in the stream than heavier particles. On the upward pump stroke, the valve opens to add water and to keep tank water quiescent. This causes the bed to "close," with heavier particles setting below lighter particles.

Many pulses occur before an increment of soil passes entirely across the bed. Each pulse leads to "hindered separation" of light and heavy particles. Eventually, Pu-enriched soil passes through the spaces between balls to settle at the "V" base, and Pu-deficient soil sluices from the jig top.

The pilot plant demonstrated that Pu mining is suitable for soil cleanup. About 90% of the soil was cleaned of Pu to less than about 500 Bq kg^{-1} (15 pCi g^{-1}) in one pass through the plant. Plutonium concentrated in 10% of the soil collected in the jig bottom. Comparable cleanup was achieved when the Pu-enriched soil was passed through the plant a second time; thus, overall contami-

nated soil volume reduction was approximately 98%. The plant achieved design capacity of $40 \text{ m}^3 \text{ wk}^{-1}$; approximately 600 m^3 were mined throughout the project.

A full-scale plant has been programmed to begin operating at JA in 1988. It should be capable of processing the entire inventory of contaminated soil within 4 y. The pilot plant has been repositioned at the Nevada Test Site for additional testing on other soils and other contaminants.

CONCLUSIONS

Plutonium mining can successfully decontaminate soil to give a true soil cleanup. The wet Pu-mining process developed by the AWC Corporation of Las Vegas, NV is inherently radiologically safe. Unlike soil relocation cleanup, true soil cleanup through mining saves top soil beneficial to plant growth, conserves waste-disposal space, recovers Pu, and, presumably, better satisfies the site owners. It is especially valuable for sites like JA, where soil is limited and is imported to meet construction requirements.

The scope of the JA cleanup is comparable to the Enewetak cleanup. However, based on pilot plant results, a "true soil cleanup" at JA is expected to cost less than 10% of that at Enewetak. There is a future for mining for cleanup.

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